An Account of the OSERVATIONS *on the* TRANSIT OF VENUS *over the* SUN, *on the 3d of June*, 1769, *by the* COMMITTEE *appointed to observe it at* Philadelphia; *drawn up, and presented to the* AMERICAN PHILOSOPHICAL SOCIETY, *held at Philadelphia, for promoting useful Knowledge*,

By JOHN EWING.

GENTLEMEN,

IT doubtless must appear strange to many, that the parallax of the Sun, which is so important and fundamental an article in Astronomy, has not been settled by Astronomers long ago, as so many things in that useful Science depend upon it. But this surprise is lessened by considering, that the smallness of the parallactic angle has eluded their most careful researches in all ages, as it is but about 8 or 9 seconds of a minute; so that the subtense of it, were it much larger than it is, must be invisible to the naked eye at the distance of 6 inches, and it is hardly possible to distinguish 10 seconds by instruments, let them be ever so skillfully made. Many methods have been devised by Astronomers, which shew the ingenuity of the inventors; but the disadvantage of them all was, that they depended upon observations to be made with a precision, which no instruments hitherto constructed could possibly accomplish. The Transits of Venus alone afford an opportunity of determining this problem with sufficient certainty, and these, from the strict laws of her motion, happen so seldom, that there cannot be more of them than two in one century, and in some centuries none at all. Three only have been observed since the creation, and the first of them by two persons only. The peculiar advantage of this phænomenon for determining the parallax of the Sun with a precision which is not to be expected from any other method, consists in its being deduced from the absolute time that elapses between the instants of the contacts with the Sun's limb, as seen from different parts of the earth; or from the difference of total durations as noted by distant observers, properly stationed for that purpose. A second of time being easily distinguished by a well regulated clock, if the aforesaid absolute difference of time

time be carefully noted, in places where it will amount to 24 minutes, it will give the parallax, ſmall as it is, within the hundreth part of a ſecond of a degree, and conſequently the diſtance of the Sun and planets within the ſeven hundredth part of the whole. In ſome Tranſits this difference of time will be greater, and in others leſs, in certain places on the earth, which renders thoſe that happen on the northern part of the Sun's diſc, in general, more favourable to our purpoſe, than thoſe that happen on the ſouthern hemiſphere. Hence it is, that altho' much was done in this matter by the ſedulity and care of Aſtronomers at the Tranſit in the year 1761, when Venus paſſed ſouth of the Sun's center, yet our expectations could not be fully anſwered by the obſervations that were then made; as it was eaſily foreſeen that much greater preciſion might be attained, from the advantageous circumſtances that would attend the Tranſit in 1769. The great proficience, which the Aſtromers made in ſettling this fundamental element, beyond what was ever known before, has only raiſed their expectations and engaged their attention to improve every advantage, that can be derived from a careful obſervation of this Tranſit. If they have not been diſappointed by unfavourable weather, we hope for the utmoſt certainty that can be gained in this matter, from the Obſervations they have made, when they ſhall be compared together. But after all, we muſt ſit down with the diſagreeable aſſurance that the diſtance of the Sun cannot be determined by them, let them be made with ever ſo great accuracy, within many thouſand miles; which will not appear ſtrange, when we conſider that his diſtance is upwards of 94 millions of miles, and that an error of a ſingle ſecond in his parallax will give an uncertainty of 10 or 11 millions of miles in his diſtance.

THIS approximation, however, is ſo much greater than could be expected, from any other method, that has ever been propoſed, that it has deſervedly engaged the attention of every civilized nation in the world; and it muſt redound to the honor of our Society, that they have taken ſuch effectual care to have proper Obſervatories erected, to furniſh them with the neceſſary inſtruments, and to appoint proper perſons, to uſe them on that occaſion.

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As the credit of our Obſervations, and the ſtreſs that will be laid upon them, in determining the parallax of the Sun, will greatly depend not only on the care and ſkill of the perſons that made them, but alſo on the goodneſs of the inſtruments, with which we were furniſhed; it has been judged proper to give the public the following account of our apparatus, and of the pains we have taken to have it in the beſt order.

As the Society were pleaſed to appoint *Joſeph Shippen*, Eſq; Dr. *Hugh Williamſon*, Mr. *Charles Thomſon*, Mr. *Thomas Prior*, and *Myſelf*, as a Committee to obſerve the Tranſit at the Obſervatory, which they had erected in this city, we ſpared neither time nor labor to have every thing neceſſary for the Obſervation in readineſs. We were provided with an excellent Sector of 6 feet radius, made by the accurate Mr. Bird, and an Equal Altitude and Tranſit Inſtrument, both belonging to the honorable Proprietaries of this province, which the Governor very generouſly lent to the Society on this occaſion. Our Teleſcopes were, a large Reflector of 4 feet focus and 7 inches aperture, which magnified from 100 to 400 times with an excellent Micrometer of Mr. Dollond's conſtruction fitted to it, which the Aſſembly of the province had ordered over at the requeſt of the Society; a Refracting Teleſcope of 24 feet focus, belonging to Miſs Norris; two Reflecting Teleſcopes of 18 inches focus, one the property of Mr. Hamilton, the late Governor of this province, and the other of Mr. Prior, together with another Reflector of 12 inches focus. With theſe, and a good time-piece, we promiſed ourſelves the pleaſure of making accurate Obſervations, if the weather ſhould prove favourable. For this purpoſe we met frequently before the Day of the Tranſit, to adjuſt our inſtruments, and to remove every local obſtruction that might hinder our Obſervations.

Some of us gave particular attention to the regulation of the time-piece, and therefore took the paſſage of the Sun's limbs over the croſs hairs of the Tranſit-Inſtrument, both forenoon and afternoon for many days before and after the Tranſit, and particularly on that day. As it had 3 horizontal hairs fixed in the focus, it afforded us 6 ſetts of correſponding altitudes, which generally

generally agreed in giving the time of apparent noon within 2 ſeconds of each other; ſo that by comparing them together daily, and applying the proper equations for correſponding altitudes, on account of the Sun's change of declination between the forenoon and afternoon Obſervations, we were aſſured of the rate of our clock's going and the time of apparent noon to a ſingle ſecond. We did not think it neceſſary to burden our minutes, with the great number of Obſervations of this kind, that we made. Let it ſuffice to ſay, that they were made with the utmoſt care, and that our time piece was fixed to a large poſt ſunk into the ground four or five feet, ſecured from ſhaking by a brick wall at the bottom, and no ways communicating with the ſides of the building.

THE long expected Day of the Tranſit came, ſo favourable to our wiſhes, that there was not the leaſt appearance of a cloud in the whole horizon from morning till night, and the ſky was uncommonly ſerene. The Committee aſſembled in the morning at the Obſervatory, examined the adjuſtment of their Teleſcopes anew, and appointed two aſſiſtants to obſerve the clock, one to count the ſeconds with an audible voice, and the other to write down the minutes as they were compleated, to prevent a miſtake in that article.

EVERY Obſerver being fixed at his Teleſcope, at leaſt half an hour before the beginning of the Tranſit; we obſerved the contacts of the limbs of Venus and the Sun at the times mentioned in the following accounts, as they were drawn up ſeparately by the Obſervers themſelves, and are here inſerted in their own words.

Account of the CONTACTS, *by* JOSEPH SHIPPEN, *Eſq*;

" I OBSERVED this very uncommon and curious Phænomenon
" with a new Reflecting Teleſcope, made by Mr. George
" Adams, whoſe tube is two feet and half an inch long, its
" aperture 4,15 inches diameter, and its magnifying power
" about 90 times. After having well adjuſted its focal diſtance,
" the Sun's limb appeared ſo well defined, that the leaſt ob-
" ſcuration of it might be clearly diſcerned by a good eye.

"In order to diſcover the firſt external contact, as near the "precise time of its happening as poſſible, I kept conſtantly "in the field of the Teleſcope, but a ſmall arch of the Sun's "limb, and only that part of it, where it was expected the "Planet would enter; by which means I believe I ſaw the "obſcuration on the limb of the Sun as near the exact time of "its beginning as the power of the Teleſcope would admit of.

"The firſt alteration which I perceived in the Sun's diſc, "was *a jagged like appearance* on a ſmall arch of the limb; as "if a ſhadow had been caſt on it with *an irregular notched edge*, "which, at every ſecond, ſeemed to increaſe with a kind of "waving and tremulous motion. I firſt perceived this change "at $2^h. 13'. 47''$ ap. time, though I was not then convinced "that that appearance was, either the Phænomenon we looked "for, or cauſed by the Planet's near approach to the Sun's "limb; but imputed it rather to ſome duſt that might acci-"dentally have fallen on the large mirror of the Teleſcope, "as I expected the contact would have ſhewn itſelf by one "ſmall arched *indent* on the Sun's limb. And it was not till "after 12 ſeconds more had paſſed, that I was certain the "contact had happened; for then, viz. at $2^h. 13'. 59''$ ap. "time, I could plainly diſtinguiſh a ſingle impreſſion, or in-"dent, in the Sun's limb; yet it was exceedingly ſmall, and "without any of the *jagged appearance* before mentioned.

"I cannot well account for theſe different appearances in "ſo ſmall a ſpace of time, but by ſuppoſing that the firſt was "occaſioned by an atmoſphere around the body of Venus, "which might have obſcured, in a ſmall degree, part of the "Sun's limb, a few ſeconds before the contact; and that after "Venus herſelf had actually entered on the Sun's limb, the "brilliancy of the Solar rays might have ſo far illuminated the "atmoſphere of Venus, as to cauſe the obſcuration at firſt "perceived to diſappear, and leave only the well defined "form of the planet on the Sun's diſc.

"On conſidering the matter in this view, I am inclined to "think that the firſt external contact did not really happen

"till

" till at leaſt 3 ſeconds after I firſt perceived the jagged obſcu-
" ration on the Sun's limb; and then it would be at
" $2^h. 13'. 50''$ ap. time.

" But if Aſtronomers agree to fix the time of the firſt con-
" tact at the beginning of that obſcuration, I think it is pro-
" bable the contact may have happened two or three ſeconds
" before I diſcerned that obſcuration: In which caſe, the con-
" tact may be ſaid to take place at $2^h. 13'.44''$ ap. time.

" In determining on the manner in which I ſhould judge of
" the *Internal Contact*, I conſidered that after Venus ſhould
" move on the Sun's diſc with half her diameter, the horned
" points occaſioned thereby in the Sun's limb would appear
" more acute, and approach nearer to each other as the planet
" proceeded till the points ſhould actually unite. From this
" reflection I was induced to think, that the inſtant of the
" cloſing of thoſe points ought to be fixed on as the preciſe
" time of the internal contact; becauſe Venus muſt then have
" paſſed the Sun's limb with her whole diameter, and both
" their circumferences, or limbs, might be ſaid to coincide.

" I therefore carefully obſerved the progreſs of the
" Planet, and ſaw very diſtinctly, as ſhe moved onwards, that
" the illuminated points of the Sun's limb became better de-
" fined; and when they approached ſo near each other as to be
" within about 8 ſeconds of touching, which was at $2^h. 31'.26''$
" ap. time, I heard one of the Obſervers call out, *Contact*;
" but as his obſervation did not ſeem to agree with the manner
" which I had fixed for judging of the contact, I continued
" viewing with the closeſt attention, in order to fix the time
" of contact according to the idea I had formed of it; and at
" $2^h. 31'. 34''$. ap. time I could ſcarcely diſtinguiſh the illu-
" minated points of the Sun's limb to be any longer ſeparate;
" for in two ſeconds more they appeared to be ſo far cloſed as
" to form a ſingle thread of light on that part of the Sun's
" limb, which a few ſeconds before had been eclipſed. I
" therefore conclude that the *apparent* firſt internal contact
" of Venus happened at $2^h. 31'. 34''$ ap. time. Yet it is

 " not

" not improbable that her *real* Contact may have happened a
" few seconds sooner, if it be certain that she has an *At-*
" *mosphere*; because *that* might have obscured the Sun's limb
" a few seconds after Venus was entirely immersed within the
" disc; in the same manner as I judged with respect to the
" external Contact, that the beginning of the Obscuration of
" the Sun's limb was occasioned by the intervention of the
" atmosphere of Venus a few seconds before her body actually
" came in contact with the Sun."

Account of the CONTACTS, *by Dr.* WILLIAMSON.

" I MADE use of a Refracting Telescope 24 feet long, which
" magnifies ninety times. The glasses were in very good or-
" der, and the air uncommonly serene, so that the Sun's limb
" appeared very distinct and well defined, whence I promised
" myself the pleasure of fixing the external contact to a second,
" but the event convinced me that I had promised too much.
" A dusky appearance once and again drew my attention to a
" particular part of the Sun's limb, but I could see no such
" dark spot there as I thought Venus must produce, and it
" was not till $2^h. 11'. 31''$ mean time, or $2^h. 13'. 46''$ apparent
" time, that I determined to stop a watch which I had in my
" hand, to ascertain the time of my Observation, least some
" accident should prevent my hearing the assistant, who stood
" at 5 or 6 yards distance by the clock counting seconds. At
" that very time I was doubtful, whether the appearance on
" the limb of the Sun was certainly occasioned by the inter-
" position of the body of Venus; for tho' the darkness was of
" some extent along the Sun's limb, yet the impression was
" not proportionably deep, supposing that it was made by
" a circle so small as Venus compared with the diameter of
" the Sun, nor was the darkness equally perfect; yet the sub-
" sequent progress of the darkness soon convinced me that I
" had not been much too hasty in noting the time of the exter-
" nal contact.

" WHEN Venus had advanced with a little more than half
" her body on the Sun, her whole eastern limb appeared faint-

" ly

" ly illuminated : This light ſeemed to encreaſe as ſhe advan-
" ced farther on the Sun, till near the time of the internal con-
" tact. By this time I was convinced that Venus is ſurroun-
" ded by a denſe atmoſphere of a conſiderable height, which
" doubtleſs had prevented my fixing the external contact,
" with that accuracy I had expected, and had occaſioned that
" inequality in the darkneſs, which I had obſerved on the
" Sun's limb.

" In determining the internal contact, which I apprehend
" was done with great exactneſs, I attended to the inſtant,
" when there was a perfect coincidence of the limb of Venus
" with the limb of the Sun, as when two circles touch inter-
" nally. This appeared at $2^h. 31'. 24''$ apparent time. I ex-
" pected by the time the aſſiſtant had counted another ſecond,
" to have ſeen light diſtinctly round the eaſtern limb of Ve-
" nus ; not ſuch a radiance as had for 7 or 8 minutes render-
" ed that part of the planet viſible ; but a certain narrow
" portion of the Sun's limb which had a very diſtinguiſhable
" appearance from the light I have mentioned. The edge of
" the Sun did not appear ſo ſoon ; nevertheleſs I fixed upon
" $2^h. 31'. 25''$ for the preciſe time of the internal contact,
" being certain, that no part of Venus was then off the Sun.
" One or two ſeconds more were counted before the Sun ap-
" peared diſtinctly without the limb of Venus. But then it
" was obvious that Venus did not then touch the Sun's limb
" in any part, ſo that the contact was certainly over."

Mr. PRIOR made his Obſervations with his own Reflecting Teleſcope, whoſe magnifying power he does not certainly know, but ſuppoſes it to be at leaſt an hundred times. He gave the following account of his Obſervation of the Contacts, viz.

" The uncertainty where Venus would touch the Sun's
" limb made me take the following method. From 8 or 9
" minutes paſt two o'clock I made it a rule to paſs my eye
" from the lower edge of the field of my Teleſcope to the
" upper, many times in a minute, and examine the limb of

" the

"the Sun ſtrictly, in hopes of diſcovering the atmoſphere of "Venus approach, ſo as to give an opportunity of taking the "contacts of the limbs to a great certainty. In paſſing my "eye along the limb of the Sun, I diſcovered a ſmall imper-"fection, which I thought muſt be the ſtroke of the at-"moſphere, but in four ſeconds I diſcovered it to be the limb "of Venus, the atmoſphere not being viſible on the Sun. "The time therefore that I note for my external contact is, "when I firſt diſcovered that imperfection on the Sun's limb, "which was at 2h. 13'. 42" apparent time. When the body of "Venus was ſomething more than one third on the Sun, I ſaw "her eaſtern atmoſphere very diſtinctly reflecting the light of "the Sun ſo ſtrongly on the limb of Venus, as to ſhew it well "defined; but as it came on the Sun, it was entirely loſt. "The time, I note for my internal Contact, was, when the "thread of light was diſtinctly ſeen all round the body of "Venus, which was at 2h. 31'. 28" apparent time."

Mr. JAMES PEARSON having obſerved the external Contact at 2h. 13'. 50" apparent time, with a ſmall Teleſcope, belonging to the honorable Proprietaries of this province, whoſe magnifying power is about 60 times; Mr. CHARLES THOMSON obſerved the internal contact with the ſame Teleſcope, of which he gave the following account, viz.

"At 2h. 29'. 11" mean time, or 2h. 31'. 26" apparent "time, I ſaw ſome tremulous rays of light paſs from the up-"per or eaſtern limb of the Sun to the eye, acroſs, and ſo as "juſt to touch the upper limb of Venus. Marking that down "therefore as the time of Contact, I counted four ſeconds, at "which time I ſaw a continued thread of light, like a ſilver "lace, but ſtill with a tremulous motion, round the eaſtern "limb of Venus, whereby it appeared to me that the whole "body of Venus was then within the diſc of the Sun. The "tremulous appearance of the rays of light, I at firſt attri-"buted to my Teleſcope reſting againſt the ſide of the Ob-"ſervatory, but afterwards apprehended might be owing to "their paſſing thro' the atmoſpere of Venus."

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The Committee having deſired me to uſe the large Reflector abovementioned, I choſe that power which magnifies the diameters of objects 300 times; with which I obſerved at $2^h. 13'. 48''$ apparent time, an obſcuration on the north-eaſtern limb of the Sun, gradually advancing forwards with a tremulous motion, which from its irregular and duſky appearance, I concluded was occaſioned by the refraction of the Sun's rays thro' the atmoſphere of Venus, which atmoſphere ſoon afterwards became very obſervable to us all. From this I was led to conclude that the Contact did not happen till about 15 or 16 ſeconds afterwards, when there was a large and evident impreſſion made on the limb of the Sun; but as the preciſe moment of the external Contact cannot be noted by an Obſerver, the body of Venus not yet being interpoſed between the Sun's limb and the eye; this Contact muſt have happened about the time that her atmoſphere made the abovementioned obſcuration, and therefore I am of opinion that the true time of the Contact ſhould be accounted at $2^h. 13'. 48''$, or it may be 3 or 4 ſeconds ſooner, when nothing but the atmoſphere of Venus, which preceded her body, appeared on the limb of the Sun. About the time that the center of Venus approached the Sun's diſc, I ſaw the whole body of Venus, her eaſtern edge being ſurrounded with a faint light, which was doubtleſs occaſioned by her atmoſphere refracting the Sun's rays. At $2^h. 29'. 11''$ mean time, or $2^h. 31'. 26''$ apparent time, I ſaw the internal contact, when the whole body of Venus was introduced within the diſc of the Sun, and the thread of light had compleatly ſurrounded her, altho' not as bright as it became in two ſeconds afterwards.

From what has been ſaid, it appears that the apparent times of the Contacts may be repreſented at one view in the following table, as they were noted by the different Obſervers.

	1ſt Exter. Contact. h. m. ſec.	1ſt Inter. Contact. h. m. ſec.	Magnifying Powers.
Joſeph Shippen, Eſq;	2. 13. 47 Ap. T.	2. 31. 34 Ap. T.	80 times.
Dr. Williamſon,	2. 13. 46	2. 31. 25 to 27	90 times.
Mr. Pearſon,	2. 13. 50	- - - - -	60 times.
Mr. Thompſon,	- - - -	2. 31. 26 to 30	60 times.
Mr. Prior,	2. 13. 42	2. 31. 28	100 times.
Myſelf,	2. 13. 48	2. 31. 26	300 times.
A well-defined black dent in ☉'s limb, at	2. 14. 3		

After the Obſervation of the Contacts, I applied myſelf to the Micrometer to meaſure the diameters of the Sun and Venus, and the diſtance of their limbs at ſundry times during the Tranſit. I had indeed frequently meaſured the equatorial diameter of the Sun before the Day of the Tranſit, and always found it to be 6 ſeconds leſs than what is given in the Nautical Almanac. The mean of 6 meaſures on that day is 31′. 31″.6, which differs but 0″,3 or three-tenths of a ſecond from what is given in the ſaid Almanac leſſened as above. Therefore I have ſtated it at 31′. 31″.3 in the following reductions and calculations.

Six meaſures of the diameter of Venus on the Sun made it 58 ſeconds. I attempted to meaſure it both ways, with the beginning of the diviſions of the vernier advanced on the ſcale of the Micrometer and the contrary, that the error of adjuſtment might have been thereby taken away. But the Micrometer did not admit of it, the diameter of Venus being a ſmall matter too large for this operation. However I took ſome meaſures this way, but they gave the diameter no more than 55″.4, which appearing too ſmall were therefore rejected.

About 20 minutes after the Contacts, I began to meaſure the neareſt diſtance of the limbs of Venus and the Sun, and continued untill the Sun was ſo low, that the meaſures could not be made with ſufficient accuracy any longer. Some of the meaſures appear to diſagree too much with the others, and therefore ſhould not be depended on; but I could not prevail upon myſelf to neglect the inſerting of them; leaſt the unuſual agreement among ſo great a number ſhould raiſe a ſuſpicion in the minds of Aſtronomers that they had not been honeſtly tranſcribed from our minutes; eſpecially as there are enough to anſwer all the purpoſes deſigned by them, which agree in giving the neareſt diſtance of the centers with ſufficient preciſion. Although theſe meaſures are ſet down in the following table with the parts of a ſecond, we would not therefore be ſuppoſed to affect an impoſſible accuracy in them, but they are ſuch as the Micrometer has given them when properly reduced.

Mean

No. of Obser.	M. Time. 1769. *June 3d,*	Ap. Time.	Nearest dist. of the limbs of ☉ and ♀	Nearest distance of their centers.	Par. of ♀ in the Vertical.	Par. of ♀ in her Path.	Par. of ♀ perpendic. to her Path.
	h. m. sec.	h. m. sec.	m. sec.	m. sec.	sec.	sec.	sec.
1	2. 53. 43	2. 55. 59	1. 8,46	14. 8,19	13,95	13,20	4,56
2	3. 5. 51	3. 8. 7	1. 48,23	13. 57,42	14,60	13,9	4,64
3	3. 11. 32	3. 13. 48	2. 4,49	13. 12,16	14,92	14,20	4,68
4	3. 14. 17	3. 16. 33	2. 10,4	13. 6,25	15,05	14,[illegible]3	4,70
5	3. 22. 7	3. 24. 23	2. 24,77	12. 33,07	15,50	14,70	4,78
6	3. 25. 45	3. 28. 0	2. 33,25	12. 34,3	15,70	14,90	4,86
7	3. 27. 37	3. 29. 52	2. 38,46	12. 29,09	15,75	15,02	4,90
8	3. 44. 31	3. 46. 46	3. 18,86	11. 57,89	16,55	15,80	5,02
9	4. 2. 31	4. 4. 46	3. 53,64	11. 23,01	17,38	16,56	5,36
10	4. 3. 41	4. 5. 56	3. 55,6	11. 21,05	17,45	1[illegible],62	5,31
11	4. 8. 39	4. 10. 54	4. 8,54	11. 8,11	17,63	16,64	5,32
12	4. 10. 9	4. 12. 24	4. 13,85	11. 2,8	17,66	16,80	5,35
13	4. 14. 53	4. 17. 8	4. 15,81	11. 0,84	17,83	17,01	5,44
14	4. 22. 5	4. 24. 20	4. 22,10	10. 53,55	18,10	17,20	5,52
15	4. 25. 37	4. 27. 52	4. 30,36	10. 46,29	18,20	17,30	5,56
16	4. 29. 47	4. 32. 2	4. 35,92	10. 40,73	18,40	17,50	5,68
17	4. 41. 57	4. 44. 12	4. 50,14	10. 26,51	18,80	17,90	5,90
18	4. 44. 0	4. 46. 15	4. 51,96	10. 24,69	18,94	17,98	5,97
19	4. 51. 18	4. 53. 33	4. 58,62	10. 18,03	19,14	18,10	6,06
20	4. 52. 16	4. 54. 31	5. 1,23	10. 15,42	19,16	18,16	6,09
21	4. 53. 27	4. 55. 42	5. 1,23	10. 15,42	19,20	18,20	6,12
22	4. 54. 52	4. 57. 7	5. 3,18	10. 13,47	19,26	18,26	6,17
23	4. 56. 30	4. 58. 45	5. 5,14	10. 11,51	19,30	18,30	6,20
24	4. 58. 29	5. 0. 44	5. 6,44	10. 10,21	19,36	18,35	6,24
25	5. 1. 35	5. 3. 50	5. 5,14	10. 11,51	19,44	18,43	6,30
26	5. 9. 29	5. 11. 44	5. 5,79	10. 10,86	19,55	18,52	6,46
27	5. 11. 52	5. 14. 7	5. 9,05	10. 7,6	19,68	18,74	6,50
28	5. 18. 29	5. 20. 44	5. 12,96	10. 3,69	19,95	18,85	6,69
29	5. 20. 29	5. 22. 43	5. 14,26	10. 2,39	20,05	18,90	6,76
30	5. 24. 17	4. 26. 31	5. 14,26	10. 2,39	20,14	18,98	6,90
31	5. 25. 59	5. 28. 13	5. 9,7	10. 6,95	20,19	18,99	6,91
32	5. 28. 33	5. 30. 47	5. 8,4	10. 8,25	20,20	19,01	6,96
33	5. 33. 39	5. 35. 53	5. 5,14	10. 11,51	20,36	19,08	7,08
34	5. 35. 45	5. 37. 59	5. 1,88	10. 14,77	20,40	19,10	7,10
35	5. 43. 17	5. 45. 31	5. 2,53	10. 14,12	20,50	19,18	7,28
36	6. 1. 13	6. 3. 27	4. 50,79	10. 26,86	20,84	19,34	7,78
37	6. 2. 39	6. 4. 53	4. 49,49	10. 27,16	20,90	19,38	7,88
38	6. 8. 7	6. 10. 21	4. 44,27	10. 32,38	20,96	19,42	7,97
39	6. 10. 4	6. 12. 18	4. 43,52	10. 33,13	21,0	19,44	8,00
40	6. 18. 37	6. 20. 51	4. 30,58	10. 46,07	21,04	19,46	8,20
41	6. 21. 49	6. 24. 3	4. 24,06	10. 52,59	21,10	19,48	8,32
42	6. 26. 13	6. 28. 27	4. 15,81	11. 0,84	21,14	19,50	8,40

No.

No. of Obser.	M. Time.	Ap. Time.	Nearest dist. of the limbs of ☉ and ♀	Nearest distance of their centers.	Par. of ♀ in the Vertical.	Par. of ♀ in her Path	Par. of ♀ perpendic. to her Path
	h. m. sec.	h. m. sec.	m. sec.	m. sec.	sec.	sec.	sec.
43	6. 32. 18	6 34. 32	4. 1,46	11. 14,19	21,18	19,50	8,60
44	6. 33. 55	6. 36. 9	4. 3,42	11. 13,23	21,20	19,46	8,68
45	6. 37. 29	6 39. 43	3. 58,2	11. 18,45	21,22	19,43	8,76
46	6. 38. 55	6. 41. 9	3. 54,29	11 22,36	21,24	19,40	8,82
47	6. 41. 39	6. 43. 53	3. 49,73	11. 26,92	21,26	19,30	8,92
48	6. 43. 57	6. 46. 11	3. 44,94	11. 31,71	21,28	19,34	8,98
49	6. 46. 25	6. 48. 39	3. 42,98	11. 33,67	21,29	19,31	9,02
50	6. 48. 49	6. 51. 3	3. 36,46	11. 39,19	21,30	19,29	9,17
51	6. 53. 17	6. 55. 31	3. 28,64	11. 48,01	21,34	19,26	9,21
52	7. 2. 1	7. 4. 15	3. 9,08	12. 7,57	21,38	19,24	9,48
53	7. 4. 33	7. 6. 47	3. 4,52	12. 12,13	21,39	19,20	9,56
54	7. 9. 26	7. 11. 40	3. 5,82	12. 11,83	21,40	19,10	9,70

The foregoing nearest distances of their centers are deduced from the measured distances of their limbs, taking their diameters as they are stated above: And the parallaxes are not computed, but measured from a projection of the disc of the earth as seen from the Sun, the projection being 21 inches and an half in diameter.

The latitude of our Observatory in Philadelphia is determined from the Observations of Messrs. Mason and Dixon with the above mentioned Sector. From a mean of thirty Observations of the passage of some stars over the Meridian, they found the latitude of the most southern point of the city of Philadelphia to be 39°. 56′. 29,″2. Our Observatory is North of this point, 25 seconds, and therefore its latitude is 39°. 56′. 54″.

In order to determine the parallax of the Sun, from the foregoing Observations, it is necessary that our longitude from some fixed Meridian should be ascertained with the most rigorous precision. For this purpose we have observed various Eclipses of Jupiter's Satellites, that they might be compared with the correspondent Observations made at Greenwich and elsewhere, when we are furnished with them.

Eclipses

Eclipses of JUPITER's SATELLITES, observed at Philadelphia, with a Two Feet Reflector.

	D. h. m. sec.	
1767. *April* 3,	7. 11. 23	Em. 2d. Ap.T.
May 30,	10. 15. 32	Em. *1st*.
June 13,	9. 18. 6	Em. *2d*.
1768. *Mar.* 1,	9. 46. 49	Im. *1st*.
April 9,	10. 37. 2	Em. *1st*.
25,	8. 56. 50	Em *1st*.
May 12,	10. 33. 9	Em. *2d*.
1769. *Feb.* 16,	14. 21. 51	Im. *1st*.
20,	15. 42. 1	Im. *2d*.
23,	16. 16. 21	Im. *1st*.
Mar 17,	12. 45. 21	Im. *2d*.

	D. h. m. sec.	
1769. *April* 3,	14. 50. 48	Im. *1st*. Ap.T.
11,	9. 49. 14	Im. *2d*.
12,	11. 15. 49	Im. *1st*.
May 5,	11. 30. 28	Im. *1st*.
With a four feet Reflector.		
June 7,	8. 44. 37	Em. *2d*.
22,	8. 27. 35	Em. *1st*.
29,	10. 21. 55	Em. *1st*.
Aug. 23,	12. 15. 48	Em. *1st*.
Sept. 11,	7. 44. 41	Em. *2d*.

Since the foregoing account has been drawn up, we have been furnished with some Observations of the eclipses of Jupiter's satellites, made by the Revd. Mr. Maskelyne, Astronomer Royal, at Greenwich. By comparing these with the like Observations made at Philadelphia and Norriton, we are enabled to settle the longitudes of our Observatories. But as there are but two or three of them correspondent with ours, we must have recourse to another method; which is first to compare them with the calculations in the Nautical Almanac, which were made for the meridian of Greenwich, that the error of the tables may be discovered by the mean of them; and then to compare ours with the same calculations, applying the errors of the tables to the longitude deduced from this comparison. We may depend upon the result of this method with much more confidence, than upon any single observation.

Here follow the Apparent Times of the Greenwich Observations compared with the calculations of the Nautical Almanac.

1769.	D. h. m. sec.	
Mar. 29,	12. 25. 7	Im. *1st*. Obs. at Gr.
29,	12. 24. 26	Do. p. calc. of N.Al.
	41	Error West.
Apr. 11,	14. 50. 23	Im. *2d*. Obs. at Gr.
11,	14. 50. 4	Do. p. calc. of N.Al.
	19	Error West.
12,	16. 16. 13	Im. *1st*. Obs. at Gr.
12,	16. 16. 13	Do. p. calc. of N.Al.
	00	

1769.	D. h. m. sec.	
April 28,	14. 35. 17	Im. *1st*. Obs. at Gr.
28,	14. 36. 14	Do. p. calc. of N.Al.
	57	Error East.
May 6,	11. 51. 2	Im. *2d*. Obs. at Gr.
6,	11. 51. 45	Do. p. calc. of N.Al.
	43	Error East.
May 16,	9. 32. 15	Em. *1st*. Obs. at Gr.
16,	9. 31. 7	D. p. calc. of N. Al.
	1. 8	Error West

1769. D.	h. m. sec.	
June 8,	9. 41. 16	Em. *1st.* Obs. at Gr.
8,	9. 41. 26	Do. p. calc. of N.Al.
	10	Error East.
15,	11. 35. 33	Em. *1st.* Obs. at Gr.
15,	11. 34. 55	Do. p. calc. of N.Al.
	38	Error West.

1769. D.	h. m. sec.	
July 1,	9. 50. 24	Em. *1st.* Obs. at Gr.
1,	9. 50. 37	Do. p. calc. of N.Al.
	13	Error East.

Now altho' the errors of the first satellite appear considerable, yet if we reject the Observation of the 16th of May as being too near to the time of Jupiter's opposition with the Sun; the mean of those, which give an eastern meridian corresponding with the calculations of the Nautical Almanac, exactly counterbalances the mean of those which give a western meridian corresponding with them. Therefore we have nothing to do but to reduce all our Observations at Norriton and Philadelphia to the meridian of Philadelphia, and then compare them with the calculations in the Nautical Almanac.

The Norriton Observations of the eclipses of Jupiter's first Satellite are as follow.

	D.	h. m. sec.	
1769. *Feb.*	16,	14. 21. 10	Im. *1st.*
	23.	16. 15. 1	Im *1st.*
April	3,	14. 49. 25	Im. *1st.*
	10,	16. 46. 0	Im. *1st.*
	12,	11. 14. 37	Im. *1st.*
May	5,	11. 29. 27	Im. *1st.*

1769	D	h. m. sec.	
May	14,	10. :. 14	Em. *1st. doubtful.*
	21,	11. 55. 13	Em. *1st.*
June	6,	10. 11. 32	Em. *1st.*
	7,	8. 43 44	Em. *2d.*
	13,	12. 5. 1	Em. *1st.*

Now if we compare the correspondent Observations at Philadelphia and Norriton on the 16th of February, the 12th of April, the 5th of May, and the 7th of June 1769, the difference of our meridians will be found from the mean of them to be 57 seconds of time. This is farther confirmed by the Observations we have made on the Transit of Mercury over the Sun, on the 9th of November, 1769, which being compleated before these sheets were printed off, we have judged proper to insert.

Apparent Time.	h. m. sec.	
The exter. contact was at	2. 36. 9	by the mean of 4 Obser. at Philadelphia,
And at - -	2. 35. 17	by the mean of 3 Obser. at Norriton.
The difference is,	52	
The inter. contact was at	2. 37. 34	by the mean of 4 Obser. at Philadelphia,
And at - - -	2. 36. 34	by the mean of 3 Obser. at Norriton.
The difference is	1. 0	

THEREFORE

THEREFORE the mean of both theſe makes the difference of our meridians 56 ſeconds of time, which muſt certainly be more accurate than what is deduced from a few correſponding Obſervations of the eclipſes of Jupiter's ſatellites; both becauſe they afford 24 compariſons, all nearly agreeing among themſelves, and becauſe theſe Tranſits, in the judgment of moſt aſtronomers, afford the beſt opportunities of ſettling the longitudes of places. Hence if we add 56 ſeconds to the time of the Norriton Obſervations of the eclipſes of Jupiter's ſatellites, they will be reduced to the meridian of our Obſervatory in Philadelphia, and may be uſed in fixing our longitude from Greenwich, in the following manner.

The calculated Time per Nautical Almanac.	The obſerved Time at Philad.	The Norriton Ob. red. to the Mer of Phil.	The Diff. of Mer. of Gr. and Phil.
D. h. m. ſec.	D. h. m. ſec.	D. h. m. ſec.	D. h ſec
1767. *May* 30, 15 16. 10Em. 1*ſt*.	30, 10. 15. 32	- - - -	5, 0. 38
June 13, 14. 17. 37Em. 2*d*	13, 9. 18 6	- - - -	4, 59. 31
1768. *Mar.* 1, 14 48. 24Im. 1*ſt*.	1, 9 46 49	- - - -	5, 1. 35
April 9, 15. 36. 34Em. 1*ſt*.	9, 10 37. 2	- - - -	4, 59. 32
25, 13. 57. 46Em. 1*ſt*.	25, 8. 56 50	- - - -	5, 0. 56
May 12, 15 34 11Em. 2*d*	12, 10. 33. 9	- - - -	5, 1. 2
1769. *Feb.* 16. 19. 22. 29Im. 1*ſt*	16, 14. 21. 51	- - - -	5, 0. 38
16, 19 22. 29Im. 1*ſt*.	- - - -	16, 14. 22. 6	5, 0. 23
20, 20. 42. 55Im. 2*d*.	20, 15. 42. 1	- - - -	5, 0. 54
23, 21. 16. 35Im. 1*ſt*.	23, 16. 16. 21	- - - -	5, 0. 14
23, 21. 16. 35Im. 1*ſt*.	- - - -	23, 16. 15. 57	5, 0 38
Mar. 17, 17. 46. 4Im. 2*d*	17, 12. 45. 21	- - - -	5, 0. 43
April 3, 19 51. 24Im 1*ſt*.	3, 14. 50. 48	- - - -	5, 0, 36
3, 19. 51. 24Im. 1*ſt*.	- - -	3, 14. 50. 21	5, 1. 3
10, 21 47. 14Im. 1*ſt*.	- - - -	10, 16. 46. 56	5, 0. 18
11, 14 50. 4Im. 2*d*.	11, 9 49. 14	- - - -	5, 0. 50
12, 16. 16. 13Im. 1*ſt*.	12, 11. 15. 49	- - - -	5, 0. 24
12, 16. 16. 13Im. 1*ſt*.	- - - -	12, 11. 15. 33	5, 0. 40
May 5, 16. 31. 20Im. 1*ſt*	5, 11. 30. 28	- - - -	5, 0. 52
5, 16. 31. 20Im 1*ſt*.	- - - -	5, 11. 30. 23	5, 0. 57
21, 16 56. 49Em 1*ſt*.	- - - -	21, 11. 56. 9	5, 0. 40
June 6, 15. 12. 59Em 1*ſt*.	- - - -	6, 10. 12 28	5, 0. 31
7, 13. 45 13Em. 2*d*.	7, 8 44. 37	- - - -	5, 0. 36
7 13 45. 13Em 2*d*.	- - - -	7, 8. 44. 39	5 0 34
13, 17. 6. 31Em 1*ſt*	- - -	13, 12. 5 57	5, 0. 34
22, 13. 28. 30Em. 1*ſt*.	22, 8. 27. 35	- - - -	5, 0. 55
29. 15 22. 11Em. 1*ſt*.	29, 10. 21. 55	- - - -	5, 0. 16
Aug. 23, 12. 15. 49Em. 1*ſt*.	23, 7. 15. 48	- - - -	5, 0. 1
Sept. 11, 12. 45. 10Em. 2*d*.	11, 7. 44 41	- - - -	5, 0. 29

Now

Now if we take the mean of all the 21 foregoing determinations of our longitude from Greenwich, by the eclipses of the first satellite, rejecting only those of March 1st, and April 9th, 1768, which differ most from the others, the result will be 5h. 0 . 35″ for the difference of our meridians. These ought evidently to be rejected, as they differ near twice as much, from the mean of the rest, as any other of the determinations do, yet the retaining of them will make no difference in the result. If the mean determination of the longitude be taken from the immersions alone, rejecting that of the 1st of March, 1768, it will be 5h. 0′. 36″, and if from the emersions alone, it will be 5h. 0′. 34″, when the Observation of the 9th of April, 1768, is excluded. Therefore the mean of both, (which should always be preferred,) is 5h. 0′. 35″.

As a farther confirmation of this conclusion; if this difference of meridians be applied to the Greenwich Observations, of the first satellite, rejecting that of the 16th of May, to reduce them to the meridian of Philadelphia, and if they are then compared with the calculations in the Nautical Almanac; we shall have the same result from them also.

The calculated Time per Nautical Almanac.			Greenwich Obs. reduced to the Merid. of Philadelphia.		Diff. of Meridian of Greenwich and Philadelphia.
1769. D.	h. m. sec.		D.	h. m. sec.	h. m. sec.
Mar. 29,	12. 24. 26	Im. *1st.*	29,	7. 24. 32	4. 59. 54
April 12,	16. 16. 13	Im. *1st.*	12,	11. 15. 38	5. 0. 35
28,	14. 36 14	Im. *1st.*	28,	9. 34. 42	5. 1. 32
June 8,	9 41. 26	Em. *1st.*	8,	4. 40. 41	5. 0. 45
15,	11. 34. 55	Em. *1st.*	15,	6. 34. 58	4. 59. 57
July 1,	9. 50. 37	Em. *1st.*	1,	4. 49. 49	5. 0. 48
April 11,	14. 50. 4	Im. *2d.*	11,	9. 49. 48	5. 0. 16
May 6,	11. 51. 45	Im. *2d.*	6,	6. 50. 27	5 1. 18

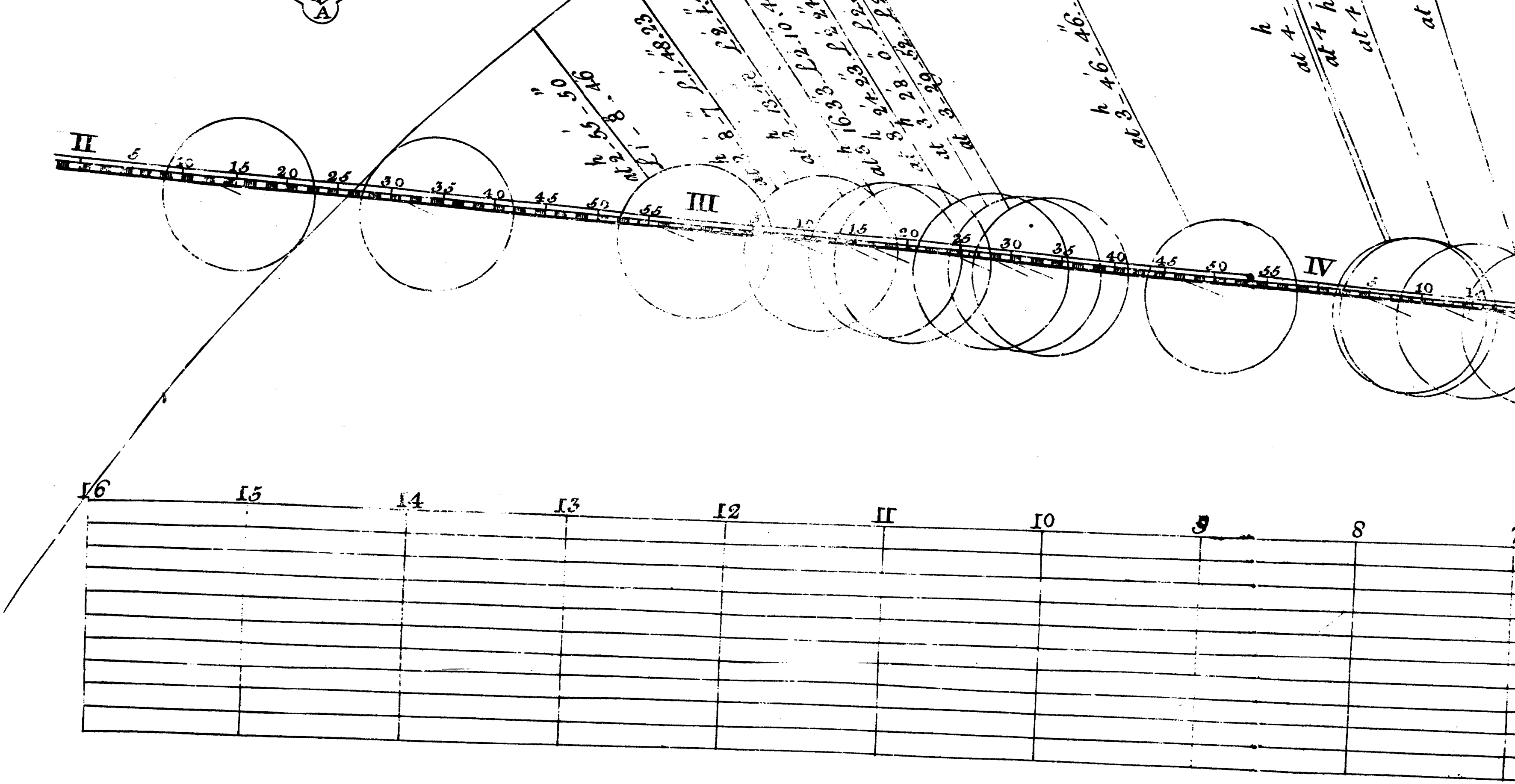
The mean of these determinations of the longitude, from the Greenwich Observations of the first satellite, is 5h. 0′. 35″. But farther if we take the mean of all the determinations, derived from the eclipses of the second satellite, it will be found to be 5h. 0′. 37″. And lastly, if the mean of all the determinations from the eclipses of both first and second satellite be chosen, the

Elements of the Projection

The Place of the Sun and Venus at the Ecliptical Conjunction	s ° 2_13_
The Place of the Ascending Node of Venus	2_14_
The Sun's Distance from the Node of Venus	1_
The Angle of her visible Path with the Ecliptic	8_
The horary Motion of Venus	
The Diameter of the Sun on the Day of the Transit	3
The Diameter of Venus	
The Geocentric nearest Distance of their Centers	10
The Geocentric Lattitude of Venus	1
The Heliocentric Lattitude of Venus	4
The Hor. Parallax of the Sun, at his mean Distance Viz. 100000 Eq. Parts	
on the Day of the Transit when his Distance was 101506 Eq. Parts	

The Sun's mean Distance in English Miles according to that Parrallax 94790550

H Dawkins; Sculp.t



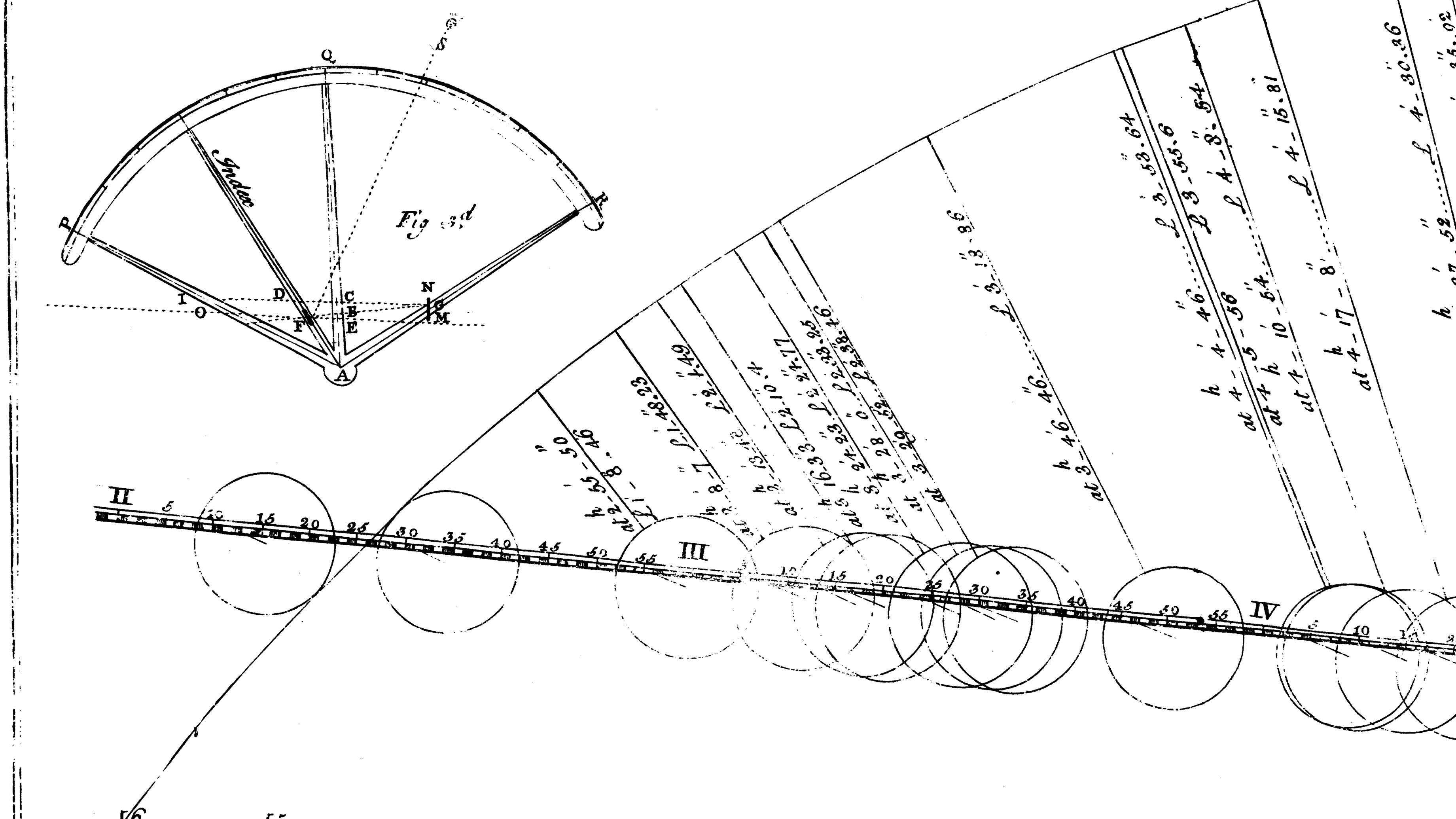
Elements of the Projection

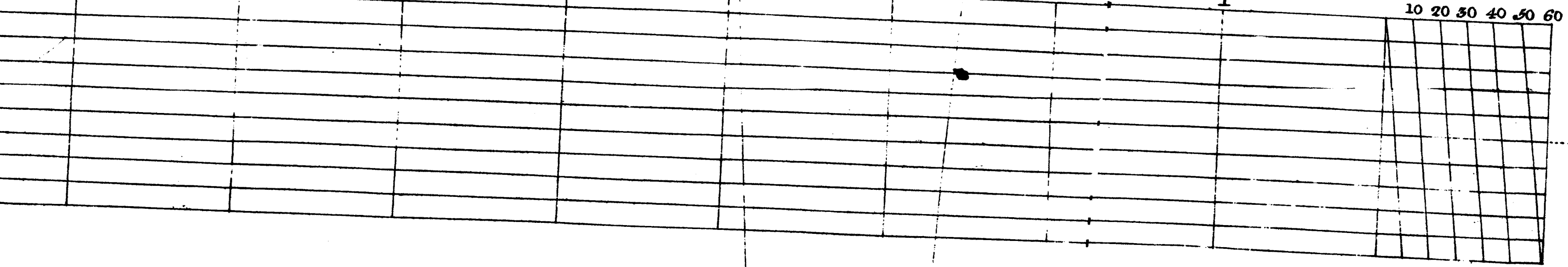
The Place of the Sun and Venus at the Ecliptical Conjunction . . . . 2_13_

The Place of the Ascending Node of Venus . . . . 2_14_

The Sun's Distance from the Node of Venus . . . . 1_

The Projection of the Transit of Venus





	s ° ′ ″
....	2-13-27-18.7
....	2-14-35-38.9
....	1-8-20.2
....	8-33-11.5
....	3-57.1765
....	31-31.3
....	58.
....	10-10.49
....	10-17.336
....	4-5.4885
....	8.684
....	8.555

94790550

The first Exter. Contact, at 2^h-$13'$-$48''$ *The first Internal Contact at* 2^h-$31'$-$26''$ Ap.T.

Observed at PHILADELPHIA.

The Horizonta
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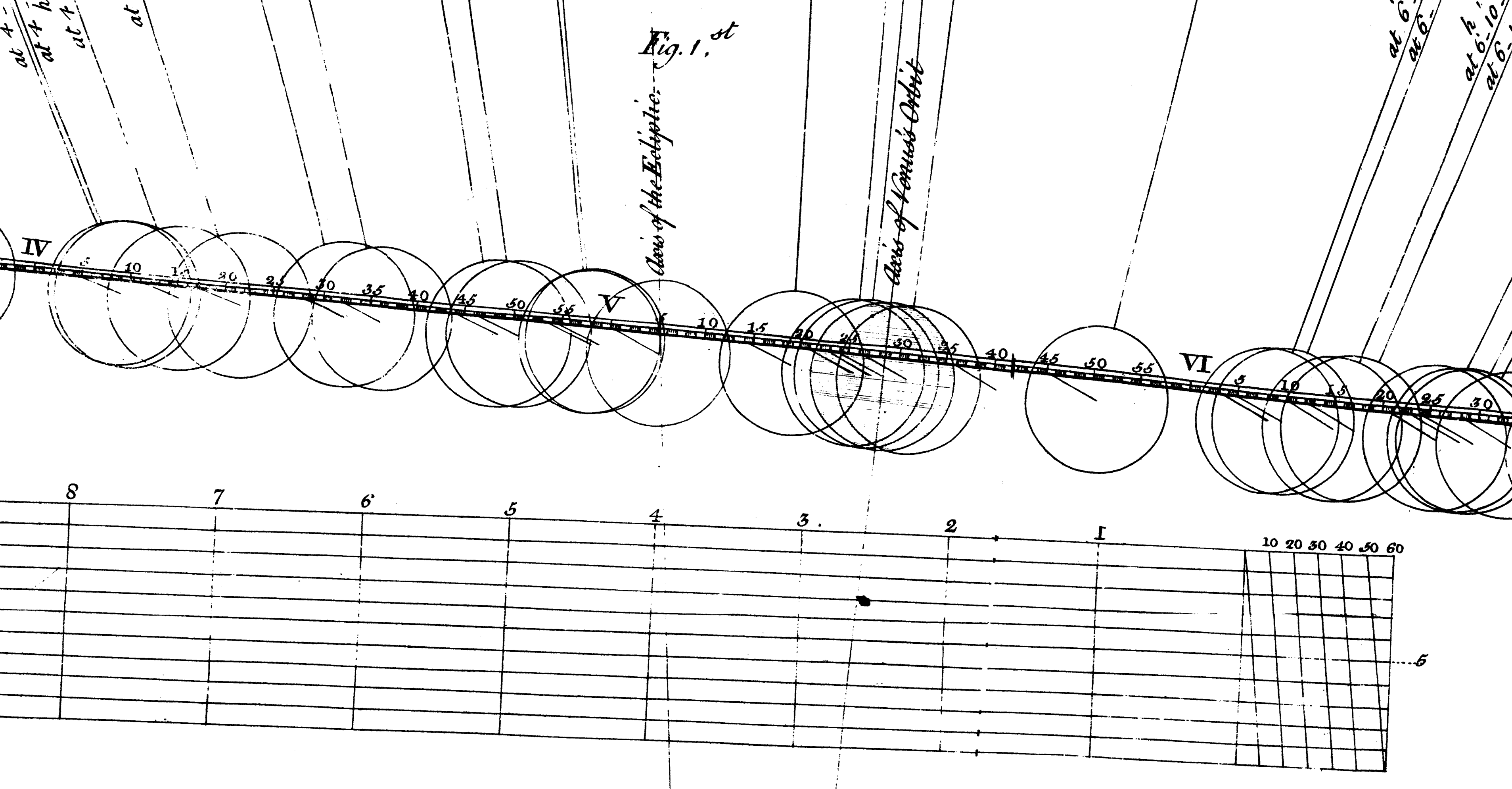
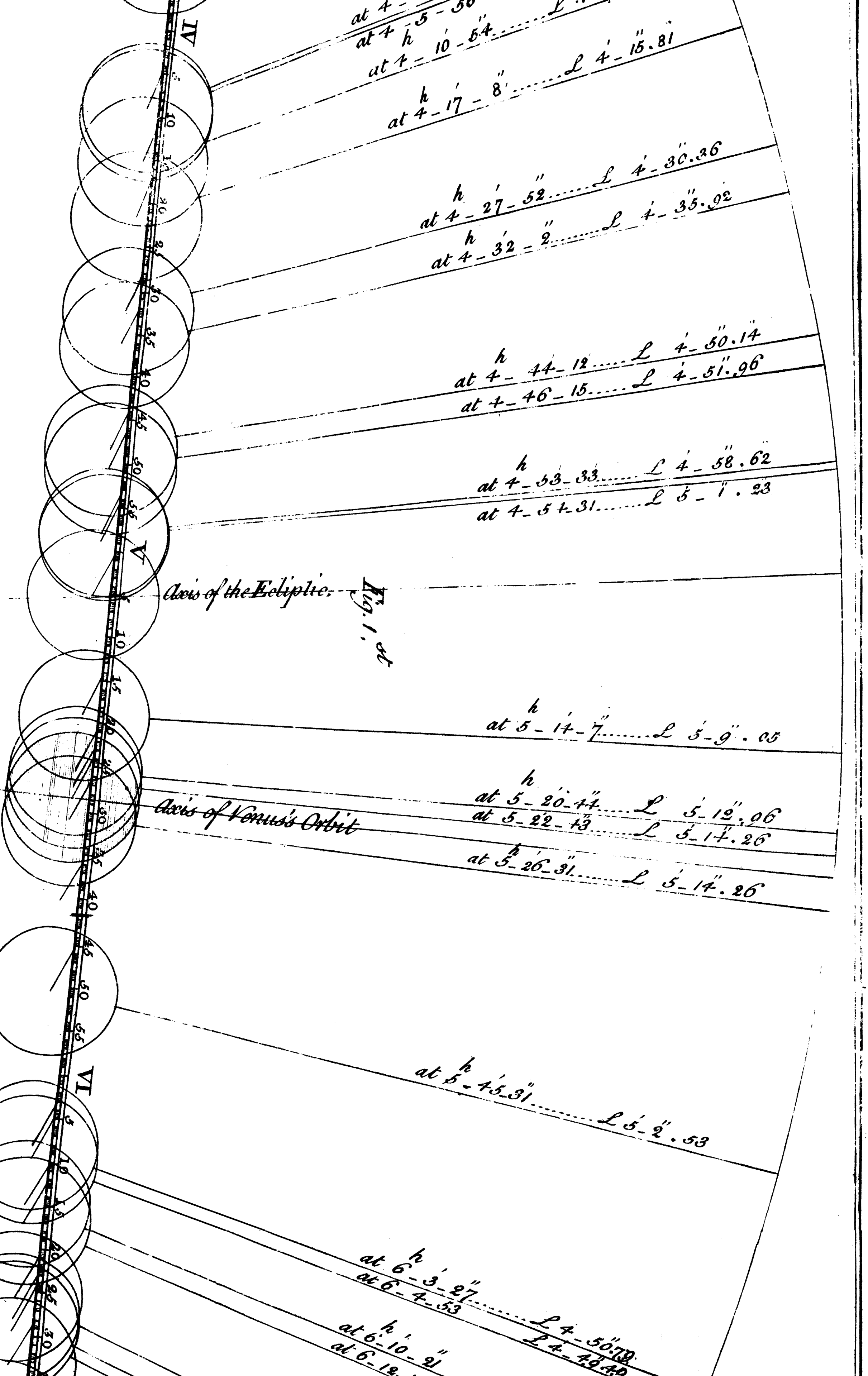
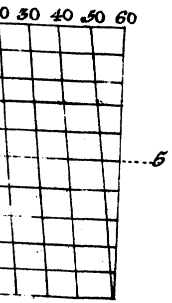


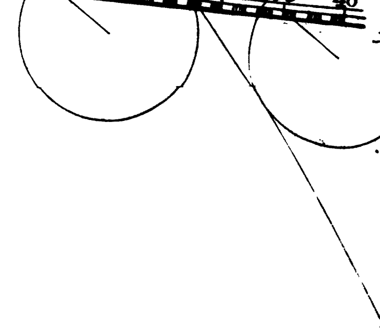
^{s} ^{o} $'$ $''$
. . . . 2_13_27_18.7
. . . . 2_14_35_38.9
. . . . 1_8_20.2

The first Exter. Contact, at 2^{h}_13$'$_48$''$. *The first Internal Contact at* 2^{h}_31$'$_26$''$ Ap.T.

The Horizont
The Day of th
Her Hor. Par


IV
at 4 - 10 - 54
L 4 - 15.81
at 4 - 17 - 8
L 4 - 30.36
at 4 - 27 - 52
L 4 - 35.92
at 4 - 32 - 2
at 4 - 44 - 12 ..... L 4 - 50.14
at 4 - 46 - 15 ..... L 4 - 51.96
at 4 - 53 - 33 ..... L 4 - 58.62
at 4 - 54 - 31 ..... L 5 - 1.23
V
Axis of the Ecliptic.
Fig. 1. at
at 5 - 14 - 7 ..... L 5 - 9.05
at 5 - 20 - 44 ..... L 5 - 12.96
at 5 - 22 - 43 ..... L 5 - 14.26
Axis of Venus's Orbit
at 5 - 26 - 31 ..... L 5 - 14.26
at 5 - 45 - 31 ..... L 5 - 2.53
VI
at 6 - 3 - 27 ..... L 4 - 50.79
at 6 - 4 - 53 ..... L 4 - 49.40
at 6 - 10 - 21





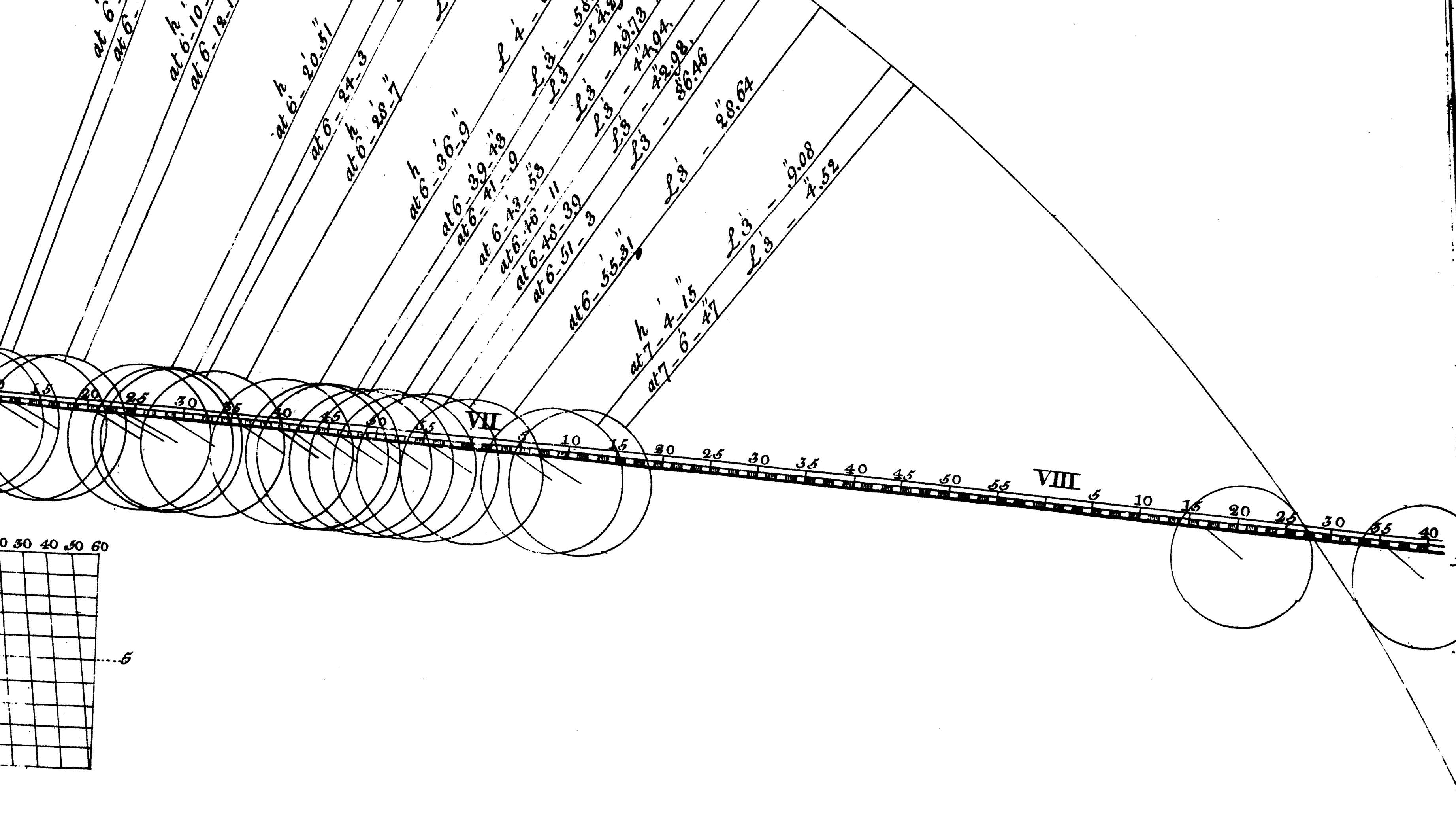
p.T.

Elements of the Projection

The Horizontal Parallax of Venus at her mean Distance Viz. 72333 Eq. Parts	31″. 38685	
The Day of the Transit when her Dist. from the Sun was 72626.45 Eq. Parts	30.069	
Her Hor. Par. from the Sun on the Day of the Transit	21.514	
Her mean Distance from the Sun in English Miles according to that Parallax	68564850	
The apparent Time of the Ecliptical Conjunction		5ʰ-5′-16″
The middle of the Transit at the Center of the Earth		5-28-29.7
The Semiduration between the internal Contacts		2-52-58.7
The Transit begins as seen at the Earth's Center at		2-16-18
And being accelerated by Parallax 3′-36″ of Time it begins at Philadᵃ, at		2-12-42
The Total Ingress as Seen at the Earths Center at		2.35-31
And being accelerated by Parallax 4.4″ of Time it happens at		2.31-27

Projected for Lat. 39°-56′-54″ and Longitude West of Greenwich 75°-8′-45″ = 5ʰ-0′-35″ of Time.

by John Ewing.

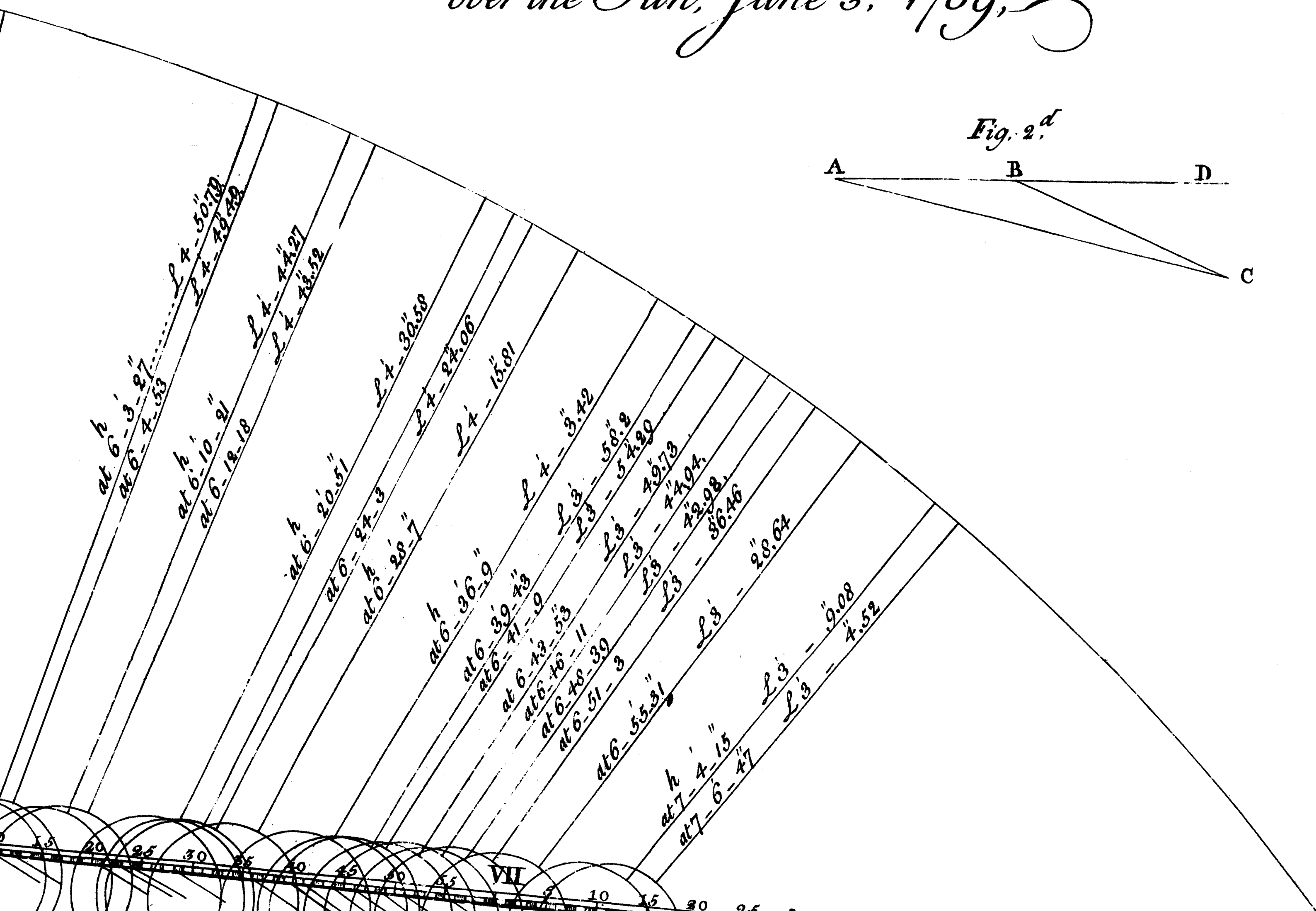


Elements of the Projection

p.T.

The Horizontal Parallax of Venus at her mean Distance Viz. 72333 Eq. Parts - - 31". 38685 - -
The Day of the Transit when her Dist. from the Sun was 72626.45 Eq. Parts - 30.069 - - - -
Her Hor. Par. from the Sun on the Day of the Transit - - - - - - - - - - - - 21.514

over the Sun, June 3d 1769,



the deduced longitude will be $5^h. 0'. 35''$. So that we may ſafely conclude, that the difference of meridians between Philadelphia and Greenwich, is $5^h. 0'. 35''$.; and that Norriton is $56''$ of time weſt of Philadelphia, and its longitude is $5^h. 1'. 31''$. weſt. With this determination we muſt be contented until farther obſervations are made, by which it may be confirmed, or rendered liable to exception.

THESE Obſervations are ſufficient to determine every thing relative to the theory of Venus, and the parallaxes of the Sun and planets, as may be ſeen by the annexed projection of the Tranſit, and the following calculations. Altho' the parallax of the Sun may be obtained from the obſerved neareſt diſtance of the centers of the Sun and Venus, yet this method cannot be ſo much depended on, as the compariſon of the contacts of the limbs obſerved in proper places, where the abſolute difference of time is conſiderable. Neverthelefs, as the public ſeem very impatient to know the reſult of what was done in this place; I have endeavoured to deduce it from our Obſervations alone; and flatter myſelf, that, in the concluſion, it will be found pretty accurate; as it is nearly the ſame, with what I had before found it to be, by an hundred and forty determinations of it, from the Obſervations of Aſtronomers on the Tranſit of 1761; and alſo from another method, the invention of the celebrated Mr. Stuart, of Glaſgow; both which I have now annexed to the following calculations.

HAVING thus collected together all the elements neceſſary for the enſuing calculation; before I proceed to it, I muſt, in juſtice to Dr. Williamſon and Mr. Prior, obſerve, that of the Micrometer meaſures, the 2d, 3d, 19th, 20th, 21ſt, 22d, 23d, 24th, and 25th were made by Mr. Prior, and the 35th, 43d, 44th, and 54th by Dr. Williamſon, with the ſame adjuſtment of the focus, that I uſed in the others.

I HAVE taken the trouble of making above fifty determinations of the middle of the Tranſit, and find from a mean of them, that the neareſt approach of their centers was at $5^h. 21'. 27''$ mean time, or $5^h. 23'. 41'',7$ apparent time, which

was

was hastened by parallax 4′. 48″ at Philadelphia; and therefore, that the central apparent time of the middle of the Transit was 5^h. 28′. 29″,7, according to our meridian.

By comparing together eighteen determinations of the nearest distance of the center of the Sun and Venus, I find the mean of them to be 10′. 3″,58, as seen in Philadelphia. But she was then depressed 6,″91 by parallax; and therefore, the geocent. nearest distance of the centers was 10′. 10″,49 = 610″,49. Therefore say,

As 72626,45 the dist. of ♀ from ⊙ : 28879,55 her dist. from ⊖ :: 610″,49 : helioc. dist. of their centers.

4. 861,0949
4. 460,5904
2. 785,6785

7. 246,2689

2. 385,1740 = 242″,7583 = 4′. 2″,7583 the helioc. dist. of their cent.

As S, 3°. 23′. 20″ the incl. of ♀ orbit to the eclip. : R :: S, 4′. 2″,758 : Sine of ⊙'s dist. from the node of ♀.

8. 771,6803
10. - - -
7. 070,2506

8. 298,5703 = 1°. 8′. 20″,23 ⊙ dist. from the node of ♀

As S, 1°. 8′. 20″,23 : R :: S, 10′. 10″,49 : S, of the angle of her visible path with the eclip.

8. 298,5703
10. - - .
7. 470,9623

9. 172,3920 = 8°. 33′. 11″,5 the angle of her visible path.

If AB represent the horary motion of ⊙ = 2,′392375. See Pl. IV. Fig. 2d.
BAC the inclination of the orbit of ♀ with the ecliptic = 3°. 23′. 20″
DBC the angle of ♀ visi. path with the eclipt. = 8°. 33′. 11″,5

Then AC will represent the horary motion of ♀ and may be found by the following proportion;

As S, ACB : AB :: S, DBC or ABC : AC.

As S, 5°. 9′. 51″,5 : 2′,3922357 :: S, 8°. 33′. 11″,5 : the hor. mot. of ♀

8. 954,3008
0. 378,8292
9. 172,3920

0. 596,9204 = 3′,952942 = 237″,17652 the hor. mot. ♀ whose log. is 2. 375,0716.

the

916,65=the diff. of the ſemidiameters of ☉ and ♀
610,49=the geo. neareſt diſt. of their centers.

Sum, 1527,14=3. 183,8789
Diff. 306,16=2. 485,9484

5. 669,8273 the log. of the ſquare of half the tranſit line between the internal contacts.
2. 834,9136=the log. of half the tranſit line between the
2. 375,0716=the log. of ♀ hor. mot. [int. cont.=683″,776
0. 459,8420=2h. 882982=2h. 52′. 58″,7=the ſemiduration between the int. contacts.

974,65=the ſum of the ſemidiameters of ☉ and ♀
610,49=the geo. neareſt diſt. of their centers.

Sum, 1585,14 3. 200,0677
Diff. 364,16 2. 561,2922

5. 761,3599
2. 880,6799=the log. of half the tranſit line between the
2. 375,0716=the log. of ♀ hor. mot. [ext. co.=759″,766
0. 505,6083=3h. 20338=3h. 12′. 12″,168=the ſemiduration between the ext. contacts.

As R : Sec, 8°. 33′. 11″,5 : : 610″,49 : geo. latitude of ♀
10. - - -
10. 004,8572
2. 785,6785
2. 790,5357=617″,356=10′. 17″,336=the geo. lat. of ♀

As 72626,45 : 28879,55 : : geo. lat. : hel. lat. of ♀
4. 861,0949
4. 460,5904
2. 790,5357
7. 251,1261
2. 390,0312=245″,4885=4′. 5″,4885=the hel. lat. of ♀

610,49
617,356
1227,846 3. 089,1440
96,866 0. 836,7038

3. 925,8478
1. 962,9239
2. 375,0716=the log. of hor. mot. of ♀
9. 587,8523=0h.387126=23′.13″,6536=the time between the middle and eclip. conjunction.

 FROM

From the apparent time of the middle of the Tranſit, viz. $5^h. 28'. 29'',7$ deduct $23'. 13'',65$, and the apparent time of the ecliptical conjunction will be $5^h. 5'. 16'',05$, when the Sun's place given in the Nautical Almanac was $2^s. 13°. 27'. 18'',7$, making the difference of our meridian from Greenwich $5^h. 0'. 35''$, as found above. To his place in the ecliptic add his diſtance from the node of Venus, found above, viz. $1°. 8'. 20'',23$, and the ſum gives the place of her aſcending node, $2^s. 14°. 35'. 38'',9$.

From the middle of the Tranſit, as ſeen at the center of the earth, viz. $5^h. 28'. 29'',7$ apparent time, deduct the ſemiduration between the internal contacts, viz. $2^h. 52'. 58'',7$, and there remains $2^h. 35'. 31''$ the apparent time of the firſt internal contact, without parallax. This I obſerved at $2^h. 31'. 26''$ apparent time ; the difference between theſe is the total effect of parallax in longitude and latitude, which is $4'. 5''$. But upon the ſuppoſition that the Sun's horizontal parallax, on the day of the Tranſit, was $8'',5204$, the total effect of parallax ſhould have been $4'. 4''$. Therefore ſay,

As $4'. 4''. = 244'' : 4'. 5'' = 245'' :: 8'',5204 : 8'',555 =$ the hor. par. of the Sun on June 3d, 1769. Then

As 100000 = his mean diſt. from the earth : 101506 = his diſt. on the day of the Tranſit, :: $8'',555 : 8'',6838$ his horizontal parallax at his mean diſtance from the earth.

This is nearly the ſame, with what is deduced from the beſt of the Obſervations made on the Tranſit of 1761 : And according to this parallax of the Sun, the mean diſtances of the planets from the Sun will be, as they are exhibited in the following table, taking a mean ſemidiameter of the earth 3985 Engliſh miles.

36693417	Mercury's	Mean diſtance from the Sun, in Engliſh miles.
68564850	Venus's	
94790550	the Earth's	
144431400	Mars's	
493005300	Jupiter's	
904307200	Saturn's	

On

On account of the difficulty of afcertaining the precife moment of the middle of the Tranfit, from the menfurations of the neareft diftances of the limbs of the Sun and Venus, and the fmall difference of time between the contacts happening, at the center of the earth, and at any particular place on its furface; Aftronomers have generally preferred the comparifon of two Obfervations at proper places, where the effects of parallax will be contrary to each other, retarding the contacts at one place and accelerating them at the other, for the purpofe of deducing the parallax and diftance of the Sun from them. We have an opportunity of confirming the former conclufions, by comparing our Obfervations with thofe that have been made at the Royal Obfervatory at Greenwich, as they have lately come to hand. They differ indeed confiderably among themfelves, probably owing to the various methods, which the Obfervers took to judge of the contacts, the account of which is not yet arrived here; yet they give a mean parrallax of the Sun nearly the fame that we have deduced from our own Obfervations at Philadelphia. I have therefore inferted them in this account of the Tranfit, as they ferve to fhew that we have not loft our labour and expence on this occafion. The method I have ufed is firft to reduce the Greenwich Obfervations of the contacts to the meridian of our Obfervatory in Philadelphia, by deducting from them the difference of longitude converted into time; and then to calculate the effect of parallax for both places at the apparent times of the contacts, upon the fuppofition of the Sun's horizontal parallax being 8″,5204 on the day of the Tranfit. From this, the Sun's horizontal parallax is found either greater or lefs, as the calculated effect of parallax is greater or lefs, than what is obferved.

The parallax of Venus in longitude at Greenwich, at the time of the firft external contact was 16″,9, which haftened the contact there 4′. 16″,5, and her parallax in lat. at the fame time was, 12″,97, which depreffed her on the difc of the Sun, lengthened her vifible path, and accelerated the contact 2′. 34″,5, fo that the total effect of her parallax was to haften the contact 6′. 51″ of time. In like manner her parallax in longitude at the internal contact was 16″,6, which haftened

I 2 it

it 4′. 12″ of time; and her parallax in latitude being 13″,42 at that time, for the same reason hastened the said contact 2′. 40″; and therefore the total effect of parallax to accelerate the internal contact at Greenwich is 6′. 52″.

At Philadelphia her parallax in longitude being 10″,74 at the external contact, hastened it 2′. 43″; and her parallax in latitude being 4″,43, lengthened her visible path on the Sun and hastened the contact 53″ of time; whence its total effect was 3′. 36″ of time. In like manner her parallax in longitude at the internal contact being 11″,95 hastened it 3′. 1″ of time, and her parallax in lat. being 4″,49 lengthened the transit line, and hastened the contact 1′. 3″; and therefore the total effect of her parallax at that time to hasten the internal contact was 4′. 4″.

Now as the total effect of parallax both at Greenwich and at Philadelphia conspired to hasten the contacts at both these places, with respect to the center of the earth, their difference is the whole effect they have on absolute time, viz. 3′. 15″ at the external contact, and 2′. 48″ at the internal contact.

The contacts were observed at Greenw. at the apparent times mentioned in the following table, according to their meridian.

Exter. Contact. h. m. sec.	Int. Contact. h. m. sec.	
7. 10. 54	7. 28. 47	by Hitchins.
7. 11. 11	- - - -	Hirst.
7. 10. 37	7. 29. 28	Dun.
7. 11. 19	7. 29. 20	Dolland.
7. 11. 30	7. 29. 20	Nairne.
7. 10. 58	7. 29. 23	Maskelyne.

These times are reduced to the meridian of Philadelphia, by subtracting 5h. 0′. 35″ from them in the following manner.

	Exter. Contact. h. m. sec.	Int. Contact. h. m. sec.	
	2. 10. 19	2. 28. 12	by Hitchins.
	2. 10. 36	- - - -	Hirst.
	2. 10. 2	2. 28. 53	Dun.
	2. 10. 44	2. 28. 45	Dolland.
	2. 10. 55	2. 28. 45	Nairne.
	2. 10. 23	2. 28. 48	Maskelyne.
M. of all is,	2. 10. 30	2. 28. 40,6	

The

THE mean of all the times of the external contacts at Philadelphia is $2^h. 13'. 46'',6$, and of the internal contacts $2^h. 31'. 28''$, as appears by pag. 51, and the difference between these means is the observed effect of parallax.

h. m. sec.	h. m. sec.	
2. 13. 46,6	2. 31. 28	at Philadelphia.
2. 10. 30	2. 28. 40,6	at Greenwich.
3. 16,6	2. 47,4	the observed effects of

parallax, at the ext. and int. contacts. Therefore say,

As $3'. 15'' = 195''$ the calculated effect of parallax at the external contact is to $3'. 16'',6 = 196'',6$: : So is the assumed horizontal parallax of the Sun on the day of the Transit $8'',5204$: to his true parallax on that day. And in like manner, as $2'. 48'' = 168''$: $2'. 47'',4 = 167'',4$: : $8'',5204$: the Sun's par on that day.

2. 290,0346	2. 225,3093
2. 293,5835	2. 223,7555
0. 930,4600	0. 930,4600
3. 224,0435	3. 154,2155
0. 934,0089=$8'',59031$ ☉ hor. par.	0. 928,9062=$8'',48997$ ☉ hor. par.

$8'',48997$

2) $17'',08028$

$8'',54014$ the mean hor. par. of ☉ on the day of the Transit.

As 100000 : 101506 : : $8'',54014$: the Sun's horizontal parallax at his mean distance from the earth.

5. 000,0000
5. 006,4917
0. 931,4650

0. 937,9567=$8'',66875$ the Sun's hor. par. at his mean distance from the earth.

THE parallax of the Sun being fixed by the mean of such comparisons as these, it is an easy matter to ascertain not only the distances of the bodies, which compose the solar system, but also their real diameters; that of the earth being previously known from the actual mensuration of some degrees on its surface. For

As the rectangle of the parallax of the Sun, and his distance from the earth, is to the real diameter of the earth; so is the rectangle of the parallax and distance of any other planet from the Sun, to its real diameter.

As

As to my delineation of the Transit; I have taken the elements of the projection from our own Observations on the 3d of June, 1769. Plate 4, fig. 2.

THE nearest approach of the centers having been determined, from the mean of a great number of computations, and found to agree very nearly with the measures that were actually made at the middle of the Transit, it was accordingly set off on the diameter of the Sun, and thro' this point a chord was drawn at right angles to the said diameter for the central transit line. This was then divided carefully into hours and minutes, according to the horary motion of Venus, determined by the preceeding calculation, in such a manner, as that the exact moment of the middle of the Transit, at the earth's center, should fall on the point of intersection between the said diameter of the Sun and transit line; this moment of time having been previously determined, by the mean of a sufficient number of computations.

THE parallaxes of Venus, in longitude and latitude, as seen from Philadelphia, having been also adapted to the apparent times of the micrometer measures, on the supposition of the Sun's horizontal par. being 8″,5204 on the day of the Transit, they were accordingly applied to the projection, by which the places of her center were determined for the said times. Round these, small circles were drawn, with the radius of 29 seconds, to represent the disc of Venus on the face of the Sun; and lines were drawn between the limbs, in the direction of their centers, of such a determined length, as the micrometer has given them. Many of the measures were taken from the farthest limb of the Sun, as well as from the nearest, to both limbs of Venus, and these measures were afterwards reduced to the nearest distance of the nearest limbs, as they are exhibited in the preceeding Table, using the diameters of the Sun and Venus, as they are stated above.

As a confirmation of the foregoing conclusions, I have subjoined the Observations of Astronomers, in different places, of the contacts and durations of the Transit of 1761, as they have sent them to the Royal Society, together with the longitudes and latitudes of the places of Observation, on which the following calculations depend.

OBSER-

OBSERVATIONS on the Transit of VENUS over the SUN, June 6th, 1761, N. S. Appar. Time.

Nam. of Places	1st Ex. Con.	1st In. Cont.	2d In. Con.	2d Ex. Con.	Duration.
	h. m. sec.	h. m. sec.	h. m. sec.	h. m. sec.	h. m. sec.
Greenwich,	- -	- -	8. 19. 0	8. 37. 9	- -
Shirburn castle,	- -	- -	8. 15. 12	8. 33. 17	- -
Saville house,	- -	- -	8. 18. 22	- - - -	- -
Spittal square,	- -	- -	8. 18. 41	- - - -	- -
Chelsea,	- -	- -	8. 18. 4	- - - -	- -
Leskard,	- -	- -	8. 0. 21	- - - -	- -
Paris,	- -	- -	8. 28. 27	8. 46. 44	- -
Bologna,	- -	- -	9. 4. 57	9. 23. 0 to 7	- -
Rome,	- -	- -	9. 9 36	- - -	- -
Drontheim,	- -	- -	9. 1. 49	- - -	- -
Upsal,	3. 20. 45	3. 37. 43 to 56 3. 38. 5	9. 28. 6	9. 46. 13 to 30	5. 50. 5 to 26
Stockholm,	3. 21. 37	3 39 23 to 25	9. 30. 10	- - -	5. 50. 41 to 47
Hernosand,	3. 20. 40	3. 38. 26 to 35	9. 28. 52	9. 46. 43	5. 50. 17 to 26
Calmar,	- -	3. 33. 1	9. 23. 40	- - -	5. 50. 39
Abo,	- -	3. 55. 50	9. 45. 59	10. 4. 42	5. 50. 9
Tornea,	3. 45. 44 to 51	4. 4. 0	9 54. 8 to 22	10. 12. 18 to 22	5. 50. 9 to 21
Cajaneburg,	- -	4. 19. 5	10. 8. 59	- - -	5. 49. 54
Tobolski,	- -	7. 0. 28	12. 49. $20\frac{1}{2}$	13. 7. $39\frac{1}{2}$	5. 48. 50
Cape G. Hope,	- -	- -	9. 39. 50	- - -	- -
Rodrigues,	- -	- -	12. 35. 47	12. 53. 18	- -
Calcutta,	- -	8. 20. 58	14. 11. 34	14. 27. 38	5. 50. 36
Madrass,	7. 31. 10	7. 47. 55	13. 39. 38	13. 55. 44	5. 51. 43
Tranquebar,	- -	- -	- -	- - -	5. 51. 33
Great Mount,	- -	- -	- -	- - -	5 51. 20

N. of Places	Latitude	Longitude fr. Greenw.	N. of Places	Latitude	Longitude fr. Greenw.
	° ′ ″	h m. sec.		° ′ ″	h. m. sec.
Greenwich,	51. 28. 37N.	0. 0. 0	Hernosand,	60. 38. 0N	1. 11. 28E.
Shirb. castle,	51. 39. 22N	0. 4. 1 W	Calmar,	56. 40. 30N	1 5. 39E.
Sav. house,	- -	0. 3. 31 E.	Abo,	60. 27. 0N	1. 28. 33E.
Spit. square,	- -	0. 0 $16\frac{1}{2}$W.	Tornea,	65. 50. 50N	1. 36 48E.
Chelsea,	- -	0. 0. 40 W	Cajaneburg,	64. 13. 30N	1. 51. 50E.
Leskard,	50. 26. 55N.	0. 18. 32 W.	Tobolski,	58. 12. 22N	4. 32. 52E.
Paris,	48. 50. 14N.	0. 9. 16 E.	C. G. Hope,	33. 55. 42 S	1. 13. 35E.
Bologna,	44. 29. 36N.	0. 45. 21 E.	Rodrigues,	19 40 40 S.	4. 12. 34E.
Rome,	41. 53. 54N.	0. 49. 53 E.	Calcutta,	22. 30 0N.	5. 53. 44E.
Drontheim,	63. 26. 10N.	0. 44. 3 E.	Madrass,	13. 8 0N	5. 20. 10E.
Upsal,	59. 51. 50N.	1. 10. 26 E.	Tranquebar,	10. 56. 0N	5. 18. 8E.
Stockholm,	59. 20. 30N.	1. 12 26 E	Gr. Mount,	- -	- -

The Parallax of the SUN, deduced from the 2d Internal Contact of the Limbs of the SUN and VENUS, in the Transit of 1761.

Cape of G. Hope, & Leskard.

h. m. sec.		Parall. ' "
9. 39. 50	*Cape,*	6. 8
1. 32. 7	Diff. Long.	
3. 7. 43		
8. 0. 21	*Lesk.*	1. 4
7. 22		7. 12

As 7.12: 7.22 : : 8'',5
☉'s Par 8'',69

Cape & Sherburne Castle.

h. m. sec.		Parrall. ' "
9. 39. 50		6. 8
1. 17. 36	Diff. Long.	
8. 22. 14		
8. 15. 12	*Shirb.*	1. 12
7. 2		7. 20

Sun's Par. 8'',15

Cape & Chelsea.

h. m. sec.		Parrall ' "
9. 39. 50		6. 8
1. 14. 15		
8. 5. 34		
8. 18. 4	*Ch.*	1. 11
7. 30		7. 19

Sun's Par. 8'',73

Cape & Saville House

9. 39. 50		6. 8
1. 14. 5		
8. 25. 45		
8. 1. 22	*Sav*	1. 11
7. 23		7. 19

Sun's Par. 8,57

Cape & Spittal Square.

9. 39. 50		6. 8
1. 13. 51		
8. 25. 59		
8. 18. 41	*Sp Sq.*	1. 11
7. 18		7. 19

Sun's Par. 8,47

Cape & Greenwich

9. 39. 50		6. 8
1. 13. 35		
8. 26. 15		
8. 19. 0	*Green.*	1. 11
7. 15		7. 19

Sun's Par 8,42

Cape & Paris.

9. 39. 50	6. 8
1. 4. 19	
8. 35. 31	
8. 28. 27	0. 54
7. 4	7. 2

Sun's Par. 8,54

Cape & Drontheim.

9. 39. 50	6. 8
0. 29. 32	
9. 10. 18	
9. 1. 49	2. 38
8. 29	8. 46

Sun's Par. 8,23

Cape & Bologna.

9. 39. 50	6. 8
0. 28. 14	
9. 11. 36	
9. 4. 57	0. 29
0. 39	6. 37

Sun's Par. 8,54

Cape & Rome.

9. 39. 50	6. 8
0. 23. 42	
9. 16. 8	
9. 9. 36	0. 13
6. 32	6. 21

Sun's Par. 8,74

Cape & Calmar.

9. 39. 50	6. 8
0. 7. 56	
9. 31. 54	
9. 23. 40	1. 59
8. 14	8. 7

Sun's Par 8,62

Cape & Upsal.

9. 39. 50	6. 8
0. 3. 9	
9. 36. 41	
9. 28. 6	2. 21
8. 35	8. 29

Sun's Par. 8,60

Cape & Hernosand.

9. 39. 50	6. 8
0. 2. 7	
9. 37. 43	
9. 28. 52	2. 26
8. 51	8. 34

Sun's Par. 8,78

Cape & Stockholm.

9. 39. 50	6. 8
0. 1. 9	
9. 38. 41	
9. 30. 10	2. 18
8. 31	8. 26

Sun's Par. 8,58

Cape & Abo.

9. 39. 50	6. 8
+0. 14. 58	
9. 54. 48	
9. 45. 59	2. 38
8. 49	8. 38

Sun's Par. 8,68

Cape & Tornea.

9. 39. 50	6. 8
+0. 3. 13	
10. 3. 3	
9. 54. 8	3. 5
8. 55	9. 13

Sun's Par. 822

Cape & Cajaneburg.

9. 39. 50	6. 8
+0. 38. 15	
10. 18. 5	
10. 8. 50	2. 59
9. 6	9. 7

Sun's Par. 8,49

Cape & Toboljki.

9. 39. 50	6. 8
3. 13. 17	
12. 59. 7	
12. 49. 20	3. 35
9. 9. 47	9. 43

Sun's Par. 8,64

Cape & Madrass.	Parall.	*Cape & Calcutta.*	Parall.	*Cape & Rodrigues.*	Parall.
h. m. sec.	′ ″	h. m. sec.	′ ″	h. m. sec.	
9. 39. 50	6. 8	9. 39. 50	6. 8	9. 39. 50	6. 8
4. 6. 35		4. 40. 9		2. 58. 59	
13. 46. 25		4. 19. 59		12. 38. 49	
13. 39. 38	0. 36	14. 11. 34	2. 14	12. 35. 47	3. 7
6. 47	6. 44	8. 25	8. 22	3. 2	3. 1
Sun's Par. 8″,74		Sun's Par. 8″,55		Sun's Par. 8″,54	

Rodrigues & Leskard.		*Rodrigues & Sherburn cast.*		*Rodrigues & Chelsea.*	
12. 35. 47	3. 7.	12. 35. 47	3. 7	12. 35. 47	3. 7
4. 31. 6		4. 16. 35		4. 13. 14	
8. 4. 41		8. 19. 12		8. 22. 33	
8. 0. 21	1. 4	8. 15. 12	1. 12	8. 18. 4	1. 11
4. 20	4. 11	4. 0	4. 19	4. 29	4. 18
Sun's Par. 8.80		Sun's Par. 8,00		Sun's Par. 8,86	

Rodrigues & Saville house.		*Rodrigues & Spittal square.*		*Rodrigues & Greenwich.*	
12. 35. 47	3. 7	12. 35. 47	3. 7	12. 35. 47	3. 7
4. 13. 4		4. 12. 50		4. 12. 34	
8. 22. 43		8. 22. 57		8. 23. 13	
8. 18. 22	1. 11	8. 18. 41	1. 11	8. 19. 0	1. 11
4. 21	4. 15	4. 16	4. 18	4. 13	4. 18
Sun's Par. 8,60		Sun's Par. 8,44		Sun's Par. 8,33	

Rodrigues & Paris.		*Rodrigues & Drontheim.*		*Rodrigues & Bologna.*	
12. 35. 47	3. 7	12. 35. 47	3. 7	12. 35. 47	3. 7
4. 3. 13		3. 28. 31		3. 27. 13	
8. 32. 29		9. 7. 16		9. 8. 34	
8. 28. 27	0. 54	9. 1. 45	2. 38	9. 4. 57	0. 29
4. 2	4. 1	5. 27	5. 45	3. 37	3. 36
Sun's Par. 8,53		Sun's Par. 8,05		Sun's Par. 8,54	

Rodrigues & Rome.		*Rodrigues & Calmar.*		*Rodrigues & Upsal.*	
12. 35. 47	3. 7.	12. 35. 47	3. 7	12. 35. 47	3. 7
3. 22. 41		3. 6. 55		3. 2. 8	
9. 13. 6		9. 28. 52		9. 33. 39	
9. 9. 36	0. 13	9. 23. 40	1. 59	9. 28. 6	2. 21
3. 30	3. 20	5. 12	5. 6	5. 33	5. 28
Sun's Par. 8,92		Sun's Par. 8,67		Sun's Par. 8,62	

Rodrigues & Hernosand.		*Rodrigues & Stockholm.*		*Rodrigues & Abo.*	
12. 35. 47	3. 7	12. 35 47	3 7.	12. 35. 47	3. 7
3. 1. 6		3. 0. 8		2. 44. 1	
9. 34. 41		9. 35. 39		9. 51. 46	
9. 28. 52	2. 26	9. 20. 10	2. 18	9. 45. 59	2. 30
5. 49	5. 33	5. 29	5. 25	5. 47	5. 37
Sun's Par. 8,90		Sun's Par. 8,51		Sun's Par. 8 75	

Rodrigues & Tornea.

h. m. sec.	Parall. ′ ″
12. 35. 47	3. 7
2. 35. 46	
10. 0. 1	
9. 54. 8	3. 5
5. 53	6. 12
Sun's Par. 8″,07	

Rodrigues & Cajaneburg.

h. m. sec.	Parall ′ ″
12. 35. 47	3. 7
2. 20. 44	
10. 15. 3	
10. 8. 59	2. 59
6. 4	6. 6
Sun's Par. 8″,45	

Rodrigues & Tobolski.

h. m. sec.	Parall. ′ ″
12. 35. 47	3. 7
+0. 20. 18	
12. 56. 5	
12. 49. 20	3. 35
6. 45	6. 42
Sun's Par. 8″,56	

Rodrigues & Calcutta.

12. 35. 47	3. 7
1. 41. 10	
14. 16. 57	
14. 11. 34	2. 14
5. 23	5. 21
Sun's Par. 8,55	

Rodrigues & Madrass

12. 35. 47	3. 7
1. 7. 36	
13. 43. 23	
13. 39. 38	0. 36
3. 45	3. 43
Sun's Par. 8,58	

Tobolski & Leskard.

12. 49. 20	3. 35
4. 51. 24	
7. 57. 56	
8. 0. 21	1. 4
2. 25	2. 31
Sun's Par. 8,16	

Tobolski & Chelsea.

12. 49. 20	3. 35
4. 33. 32	
8. 15. 48	
8. 18. 4	1. 11
2. 16	2. 24
Sun's Par. 8,02	

Tobolski & Saville house.

12. 49. 20	3. 35
4. 33. 22	
8. 15. 58	
8. 18. 22	1. 12
2. 34	2. 24
Sun's Par. 8,99	

Tobolski & Spittal square.

12. 49. 20	3. 35
4 33 9	
8 16. 11	
8 18. 41	1. 11
2. 30	2. 24
Sun's Par. 8,85	

Tobolski & Greenwich.

12. 49. 20	3. 35
4. 32. 52	
8. 16. 28	
8. 19. 0	1. 11
2. 32	2. 24
Sun's Par. 8,97	

Tobolski & Paris.

12. 49. 20	3. 35
4. 23. 36	
8. 25. 44	
8. 28. 27	0. 54
2. 43	2. 41
Sun's Par. 8,60	

Tobolski & Bologna.

12. 49. 20	3. 35
3. 47. 31	
9. 1. 49	
9. 4. 57	0. 29
3. 8	3. 6
Sun's Par. 8,59	

Tobolski & Rome.

12. 49. 20	3. 35
3. 42. 59	
9. 6. 21	
9. 9. 36	0. 13
3. 15	3. 22
Sun's Par. 8,20	

Tobolski & Calmar.

12. 49. 20	3. 35
3. 27. 13	
9. 22. 7	
9. 23. 40	1. 59
1. 33	1. 36
Sun's Par. 8,23	

Tobolski & Upsal.

12. 49. 20	3. 35
3 22. 26	
9. 26. 54	
9. 28. 6	2. 21
1. 12	1. 14
Sun's Par. 8,27	

Tobolski & Stockholm.

12. 49. 20	3. 35
3. 20. 26	
9 28. 54	
9. 30. 10	2. 18
1. 16	1. 17
Sun's Par. 8,39	

Tobolski & Calcutta.

12. 49 20	3. 35
1. 20. 52	
14. 10. 12	
14. 11. 34	2. 14
1. 22	1. 21
Sun's Par. 8,61	

Tobolski & Madrass.

12. 49. 20	3. 35
0. 47 18	
13. 30. 38	
13. 39. 38	0. 36
3. 0	2 59
Sun's Par. 8,55	

Cajaneburg

Cajaneburg & Sav. house.	Parall.
h. m. sec.	′ ″
10. 8. 59	2. 59
1. 52. 20	
8. 16 39	
8. 18 22	1. 11
1 43	1 46
Sun's Par. 8″,11	

Cajaneb. & Spittal square.	Parall.
h. m. sec.	′ ″
10. 8. 59	2. 59
1 52. 7	
8. 16. 52	
8. 18. 41	1. 11
1. 49	1. 48
Sun's Par. 8″,58	

Cajaneburg & Greenwich.	Parall
h. m. sec.	′ ″
10 8. 59	2. 59
1. 51. 50	
8. 17. 9	
8. 19. 0	1. 11
1. 51	1. 48
Sun s Par. 8″.74	

Cajaneburg & Paris.	
10. 8. 59	2. 59
1 42 34	
8. 20. 25	
8. 28. 27	0. 54
2 2	2. 5
Sun's Par. 8,30	

Cajaneburg & Rome.	
10. 8. 59	2. 59
1. 2. 7	
9. 6. 52	
9. 9. 30	0. 13
2 44	2. 46
Sun's Par. 8,33	

Cajaneburg & Bologna	
10. 8 59	2. 59
1. 6. 29	
9. 2 30	
9. 4. 57	0. 29
2. 27	2. 30
Sun's Par. 8,33	

Cajaneburg & Madrass	
10. 8. 59	2. 59
3 28. 20	
13. 37 19	
13 39. 38	0. 36
2. 19	2. 23
Sun's Par. 8,27	

Stockholm & Spittal square.	
9. 30. 10	2. 18
1. 12. 43	
8. 17. 37	
8 18. 41	1. 11
1. 4	1. 7
Sun's Par. 8,12	

Stockholm & Greenwich.	
9. 30. 10	2. 18
1. 12. 20	
8. 17. 50	
8. 19. 0	1. 11
1. 10	1. 7
Sun's Par. 8,88	

Stockholm & Paris.	
9. 30. 10	2 18
1. 3. 10	
8 27. 0	
8. 28. 27	0. 54
1. 27	1. 24
Sun's Par. 8,80	

Stockholm & Bologna.	
9. 30. 10	2. 18
0. 27. 5	
9. 3. 5	
9. 4 57	0. 29
1. 52	1. 49
Sun's Par. 8,73	

Stockholm & Rome.	
9. 30. 10	2. 18
0 22. 33	
9. 7. 37	
9. 9. 36	0. 13
1. 59	2. 5
Sun's Par. 8,09	

Stockholm & Madrass.	
9. 30. 10	2. 18
4. 7. 44	
13 37. 54	
13. 39. 38	0. 36
1. 44	1. 42
Sun's Par. 8,67	

Upsal & Leskard.	
9. 28. 6	2. 21
1. 28. 58	
7. 59. 8	
8. 0. 21	1. 4
1. 13	1. 17
Sun's Par. 8,06	

Upsal & Saville house	
9. 28. 6	2. 21
1. 10 56	
8. 17. 10	
8. 18. 22	1. 11
1. 12	1. 10
Sun's Par. 8,74	

Upsal & Paris.	
9. 28. 6	2. 21
1. 1. 10	
8 26. 56	
8. 28. 27	0. 54
1. 31	1. 27
Sun's Par. 8,89	

Upsal & Bologna.	
9. 28. 6	2. 21
0. 25. 5	
9. 3. 1	
9 4. 57	0. 29
1. 56	1. 52
Sun's Par. 8,[illegible]0	

Upsal & Rome.	
9. 28. 6	2. 21
0. 20. 33	
9. 7. 33	
9 9. 36	0. 13
2. 3	2. 8
Sun's Par. 8,17	

Upsal & Madrass.

h. m. sec.	Parall. ′ ″
9. 28. 6	2. 21
4. 9. 44	
13. 37. 50	
13. 39. 38	0. 36
1. 48	1. 45
Sun's Par. 8″,74	

Calcutta & Saville house.

h. m. sec.	Parall. ′ ″
14. 11. 34	2. 14
5. 54. 14	
8. 17. 20	
8. 18. 22	1. 11
1. 2	1. 3
Sun's Par. 8″,37	

Calcutta & Paris.

h. m. sec.	Parall. ′ ″
14. 11. 34	2. 14
5. 44. 28	
8. 27. 6	
8. 28. 27	0. 54
1. 21	1. 20
Sun's Par. 8″,61	

Calcutta & Bologna.

14. 11. 34	2. 14
5. 8. 23	
9. 3. 11	
9. 4 57	0. 29
1. 46	1. 45
Sun's Par. 8,58	

Calcutta & Madrass.

14. 11. 34	2. 14
0. 33. 34	
13. 38. 0	
13. 39. 38	0. 36
1. 38	1. 38
Sun's Par. 8,50	

Abo & Leskard.

9. 45. 59	2. 30
1. 47. 5	
7. 58. 54	
8. 0 21	1. 4
1. 27	1. 26
Sun's Par. 8,60	

Abo & Rome.

9. 45. 59	2. 30
0. 38. 40	
9. 7. 19	
9. 9. 36	0. 13
2. 17	2. 17
Sun's Par. 8,50	

Hernosand & Rome.

9. 28. 52	2. 26
0. 21. 35	
9. 7. 17	
9. 9. 36	0. 13
2. 19	2. 13
Sun's Par. 8,88	

Calmar & Madrass.

9. 23. 40	1. 59
4. 14. 31	
13. 38. 11	
13. 39. 38	0. 36
1. 27	1. 23
Sun's Par. 8,91	

Sherburne & Tornea.

8. 15. 12	1. 12
1. 40. 49	
9. 56. 1	
9. 54. 8	3. 5
1. 53	1. 53
Sun's Par. 8,50	

Greenwich & Paris.

8. 19. 0	1. 11
0. 9. 16	
8. 28. 16	
8. 28. 27	0. 54
17	17
Sun's Par. 8,50	

Greenwich & Leskard.

8. 19. 0	1. 11
0. 18. 32	
8. 0. 28	
8. 0. 21	1. 4
7	7
Sun's Par. 8,50	

The parallax of the Sun may also be deduced from the total duration of the Transit, as observed in different places, in the following manner.

Tranquebar & Calmar.

h. m. sec.	Parall. ′ ″
5. 51. 33	6. 24
5. 50. 39	7. 21
54	57
Sun's Par. 8″,05	

Tranquebar & Upsal.

h. m. sec.	Parall. ′ ″
5. 51. 33	6. 24
5. 50. 26	7. 33
1. 7	1. 9
Sun's Par. 8″,25	

Tranquebar & Abo.

h. m. sec.	Parall ′ ″
5. 51. 33	6. 24
5. 50. 9	7. 46
1. 24	1. 22
Sun's Par. 8″.71	

Tranquebar & Cajaneburg.

5. 51. 33	6. 24
5. 49. 54	8. 5
1. 39	1. 41
Sun's Par. 8,33	

Tranquebar & Tobolski.

5. 51. 33	6. 24
5. 48. 50	9. 3
2. 43	2. 39
Sun's Par. 8,67	

Madrass & Stockholm.

5. 51. 43	6. 33
5. 50. 42	7. 34
1. 1	1. 1
Sun's Par. 8,50	

Madrass & Tornea.	Parall.	*Great Mount & Abo.*	Parall.	*Great Mount & Tobolski.*	Parall.
h. m. sec.	′ ″	h. m. sec.	′ ″	h. m. sec.	′ ″
5. 51. 43	6. 33	5. 51. 20	6. 33	5. 51 20	6. 33
5. 50. 9	8. 7	5. 50 9	7. 46	5. 48. 50	9. 3
1. 34	1. 34	1. 11	1. 13	2. 30	2. 30
Sun's Par. 8″,50		Sun's Par. 8″.26		Sun's Par. 8″,50	
Cajaneburg & Upsal.		*Cajaneburg & Calmar.*		*Tobolski & Abo.*	
5. 49. 54	8. 5.	5. 49. 54	8 5	5. 48 50	9. 3
5. 50. 26	7. 33	5. 50. 39	7. 21	5 50 9	7. 46
32	32	9. 45	44	1. 19	1. 17
Sun's Par. 8,50		Sun's Par. 8,70		Sun's Par. 8,72	

The parallax of the Sun may also be determined, by comparing the times of the internal contacts, as observed in various places, with the time of their happening as observed at the center of the earth. For this purpose the following elements are used, as they were calculated by Mr. Short, from the measures made at the Transit in 1761, viz; the diameter of the Sun 31′. 31″, the diameter of Venus 59″, her horary motion 3′.59″,8, the angle of her path 8′. 30″.10, the nearest dist. of their centers 9′. 32″, and the diff. of their horizontal parallaxes 21″,35. Hence the ap. time of the 1st and 2d internal contacts was 2h. 22′. 3″, and 8h. 20′. 4″, reckoned by the meridian of Greenwich, without parallax, and the central duration was 5h. 58′. 1″.

Central Time & *Upsal.*	Parall.	Central Time & *Upsal.*	Parall.	Central Time & *Hernosand.*	Parall.
h. m. sec.	′ ″	h. m. sec.	′ ″	h. m. sec.	′ ″
2. 22. 3	0. 0	2 22. 3	0. 0	2. 22. 3	0. 0
1. 10. 26		1. 10. 26		1. 11. 28	
3. 32. 29		3. 32. 29		3. 33. 31	
3 37. 56	5. 12	3. 37. 43	5. 12	3. 38. 35	5. 10
5. 27		5. 14		5. 4	
Sun's Par. 8″,91		Sun's Par. 8″,55		Sun's Par. 8″,33	
Central Time & *Hernosand.*		Central Time & *Cajaneb.*		Central Time & *Stockholm.*	
2. 22. 3	0. 0	2. 22. 3	0. 0	2. 22. 3	0. 0
1. 11. 28		1. 51. 50		1. 12. 26	
3. 33. 31		4. 13. 53		3. 34. 29	
3. 38. 26	5. 10	4. 19. 5	5. 6	3. 39. 29	5. 16
4. 55		5. 12		5. 0	
Sun's Par. 8.09		Sun's Par. 8,66		Sun's Par. 8,07	

Central

Central Time & *Abo*	Parall.
h. m. sec.	′ ″
2. 22. 3	0. 0
1. 28 33	
3. 50. 36	
3. 55. 50	5 16
5. 14	
Sun's Par. 8″,44	

Central Time & *Tornea.*	Parall.
h. m. sec.	′ ″
2. 22. 3	0. 0
1. 36. 48	
3. 58. 51	
4. 4. 0	5. 2
5. 9	
Sun's Par. 8″,69	

Central Time & *Calmar.*	Parall.
h. m. sec.	′ ″
2. 22. 3	0. 0
1. 5. 39	
3. 28. 42	
3. 33. 5	5. 22
5. 23	
Sun's Par. 8″,52	

Central Time & *Tobolski*	
2. 22. 3	0. 0
4. 32. 52	
0. 54. 55	
7. 0. 28	5. 28
5. 33	
Sun's Par. 8,63	

Central Time & *Madrass.*	
2 22. 3	0. 0
5. 20. 10	
7. 42. 13	
7. 47 55	5. 57
5. 42	
Sun s Par. 8,14	

Central Time & *Calcutta.*	
2. 22. 3	0. 0
5 53. 44	
8. 15. 47	
8 20. 58	5. 16
5. 11	
Sun's Par. 8,36	

THE Sun's Parallax deduced from the observed and calculated Times of the 2d internal contact.

Central Time & *Spit. squa.*	Parrall
h. m. sec.	′ ″
8. 20. 4	0. 0
0 0. 17	
8. 19. 48	
8. 18. 41	1. 11
1. 7	
Sun's Par. 8″91	

Central Time & *Sav. House.*	Parall.
h. m. sec.	′ ″
8. 20. 4	0. 0
0. 0. 30	
8. 19 34	
8. 18. 22	1. 11
1. 12	
Sun's Par. 8″,67	

Central Time & *Paris.*	Parall.
h. m. sec.	′ ″
8. 20. 4	0. 0
0. 9 16	
8 29. 20	
8. 28. 27	0. 54
53	
Sun's Par. 8″,34	

Central Time & *Bologna.*	
8. 20. 4	0. 0
0. 45. 21	
9. 5. 25	
9. 4. 57	0. 29
28	
Sun's Par. 8,21	

Central Time & *Cape.*	
8 20. 4	0. 0
1. 13. 35	
9. 33. 39	
9. 39. 50	6. 8
6. 11	
Sun's Par. 8,58	

Central Time & *Upsal.*	
8. 2 . 4	0. 0
1. 10. 26	
9. 30. 30	
9 28. 9	2. 21
2. 21	
Sun's Par. 8,50	

Central Time & *Upsal.*	
8. 20. 4	0. 0
1. 10. 26	
9. 30. 30	
9. 28. 7	2. 21
2. 23	
Sun's Par. 8,62	

Central Time & *Upsal.*	
8. 20. 4	0. 0
1 10. 26	
9. 20. 30	
9. 28. 3	2. 21
2. 27	
Sun's Par. 8,86	

Central Time & *Stockholm.*	
8. 20. 4	0: 0
1. 12. 26	
9. 32. 30	
9. 30 11	2. 18
2. 19.	
Sun's Par. 8,56	

Central Time & *Stockholm*.	Parall.
h. m. ſec.	′ ″
8 20. 4	0. 0
1. 12. 26	
9. 32. 30	
9. 30. 8	2. 18
2. 22	
Sun's Par. 8″,75	

Central Time & *Abo*.	Parall.
h. m. ſec.	′ ″
8. 20 4	0. 0
1. 28. 33	
9. 48. 37	
9. 45. 59	2. 30
2. 38	
Sun's Par. 8″,95	

Central Time & *Cajaneb*.	Parall.
h. m. ſec.	′ ″
8. 20. 4	0. 0
1. 51. 50	
10. 11. 54	
10. 8. 50	2. 59
2. 55	
Sun's Par. 8″,31	

Central Time & *Tobolſki*	
8. 20. 4	0. 0
4. 32. 52	
12. 52. 56	
12. 49. 20	3. 35
3. 36	
Sun's Par. 8,54	

Central Time & *Calmar*.	
8. 20. 4	0. 0
1. 5. 39	
9. 25. 43	
9. 23. 40	1. 59
2. 3	
Sun's Par. 8,78	

Central Time & *Rodrigues*.	
8. 20. 4	0. 0
4. 12. 34	
12. 32. 38	
12. 35. 47	3. 7
3. 9	
Sun's Par. 8,59	

Central Time & *Calcutta*.	
8. 20. 4	0. 0
5. 53. 44	
14. 13. 48	
14. 11. 34	2. 14
2. 14	
Sun's Par. 8,50	

The Sun's parallax is alſo found, by comparing the total duration between the internal contacts, as it was obſerved in different places, with the duration at the center of the earth, viz. 5h. 58′. 1″.

Cent. Duration & at *Upſal*	Paral
h. m. ſec.	′ ″
5. 58. 1	0. 0
5. 50. 7	7. 33
7. 54	
Sun's Par. 8″ 89	

Cent. Duration & at *Upſal*.	Parall.
h. m. ſec.	′ ″
5. 58. 1	0. 0
5. 50. 2	7. 33
7. 59	
Sun's Par. 8″,98	

Cent. Duration & at *Upſal*	Parall
h. m. ſec.	′ ″
5. 58. 1	0. 0
5. 50. 26	7. 33
7. 35	
Sun's Par. 8″,54	

Cent. Durat. & at *Calmar*.	
5. 58. 1	0. 0
5. 49. 54	8. 5
8. 7	
Sun's Par. 8,53	

Cent. Dur. & at *Hernoſand*.	
5. 58. 1	0. 0
5. 50. 26	7. 36
7. 35	
Sun's Par. 8,48	

Cent. Dur. & at *Hornoſand*.	
5. 58. 1	0. 0
5. 50. 17	7. 36
7. 44	
Sun's Par. 8,65	

Cent. Dur. & at *Stockholm*	
5. 58. 1	0. 0
5. 50. 45	7. 34
7. 16	
Sun's Par. 8,16	

Cent. Dur. & at *Stockholm*.	
5. 58. 1	0. 0
5. 50. 42	7. 34
7. 19	
Sun's Par. 8,22	

Cent. Dur. & at *Abo*	
5. 58. 1	0. 0
5. 50. 9	7. 46
7. 52	
Sun's Par. 8,61	

Cent. Dur. & at *Cajaneb.* Parall. h. m. sec. ′ ″ 5. 58. 1 — 0. 0 5. 49. 54 — 8. 5 8. 7 Sun's Par. 8″,53	Cent. Dur. & at *Tobolski* Parall. h. m. sec. ′ ″ 5. 58. 1 — 0. 0 5. 48. 50 — 9. 3 9. 11 Sun's Par. 8″,63	Cent. Dur. & at *Tranqueb.* Parall. h. m. sec. ′ ″ 5. 58. 1 — 0. 0 5. 51. 33 — 6. 24 6. 28 Sun's Par. 8″,59
Cent. Dur. & at *Madrass.* 5. 58. 1 — 0. 0 5. 51. 43 — 6. 33 6. 18 Sun's Par. 8,17	Cent. Dur. & at *Calcutta.* 5. 58. 1 — 0. 0 5. 50. 36 — 7. 30 7. 25 Sun's Par. 8,40	Cent. Dur. & at *Gr. Mount* 5. 58. 1 — 0. 0 5. 51. 20 — 6. 33 6. 41 Sun's Par. 8,67
Cent. Dur. & at *Tornea.* 5. 58. 1 — 0. 0 5. 50. 15 — 8. 7 7. 46 Sun's Par. 8,13		

THE mean of all the preceeding determinations of the Sun's parallax is 8″,52 on the day of the Tranſit, in June 1761, which gives 8″,65 for his horizontal parallax at his mean diſt. from the earth.

MR. Stuart of Glaſgow, whom I mentioned before, deduces the parallax and diſtances of the bodies that compoſe the ſolar ſyſtem, from the Newtonian theory of gravitation, and the periodical times of the Sun and Moon. As he proceeds upon the ſuppoſition that the diſtance of the Sun from the earth is very great, it would therefore ſeem, that the concluſion ſhould be accurate, in proportion to the greatneſs of that diſtance. His method depends upon a ſeries of propoſitions, with long and difficult demonſtrations; ſo that the rules of calculation are not very obvious, without a conſiderable knowledge of geometry, in general, and a particular acquaintance with his very uſeful and ingenious treatiſe. I was deſirous of ſeeing what agreement there was between the reſult of his method of calculation, and the Obſervations made on the Tranſit of Venus; and therefore amuſed myſelf in a leiſure hour with the compariſon. As it may be agreeable to ſome, who have not time to read over the book, and to others, whoſe acquaintance with the mathematics will not admit of it, to have the practical

rules

rules of computation deduced from his propositions; I shall annex them to the foregoing calculations, together with the determination of the Sun's parallax and distance derived from them.

A Calculation of the horizontal Parallax and Distance of the Sun, according to Mr. Stuart's Method, from the Principles of Gravitation.

1. As the cube root of the square of the Moon's periodic revolution round the Earth, viz. $\overline{27,32162036}|^{\frac{2}{3}}$

Is to the cube root of the square of her revolution from apogee to apogee, viz. $\overline{27,554535}|^{\frac{2}{3}}$

So is 1, to a fourth number, which call A.

2. As $5A-3 : A-1 :: 1 :$ a fourth number, which call B

3. As the rectangle of B and the square of the periodic time of the Earth round the Sun, viz. $B \times \overline{365,2564}|^{2}$

Is to the square of the periodic time of the Moon round the Earth, viz. $\overline{27,32162036}|^{2}$

So is 1, to a fourth number, which call $C = 1,999840899$.

4. As $\overline{C-1}|^{2} : 12 :: C :$ to a fourth number; to which add 1, and from the square root of that sum subtract 1, and multiply the remainder by the half of $C-1$, or 0,4999204495, and call that product $D = 1,9999715505$.

5. Subtract D from 2, multiply the remainder by D, and call the square root of the product E.

6. As three times the Moon's mean distance from the Earth, in semidiameters of the Earth is to E, so is R. to the tang. of the Sun's hor. parallax at his mean distance $= 8'',65$.

7. As $E : 3 ::$ the Moon's mean dist. in miles : the Sun's mean dist. in miles $= 94982600$.

L In

In determining the parallax of the Sun, from the observation made in our Obſervatory on the 3d of June, 1769, I have only made uſe of the time of the internal contact, as I noted it on that day, together with ſome of my own Micrometer obſervations, without attending to thoſe of the other gentlemen who obſerved with me. But, as the Society has a right to expect a full account of the reſult of the other Obſervations, which were made on that occaſion; and as ſuch account may tend to corroberate the for going calculations, I have, with Dr. Williamſon's permiſſion, ſubjoined a calculation of his, founded entirely on his own Obſervation, which being very ſhort, I have inſerted entire in his own words, except what refers to the manner in which he judged of the contacts, &c. which I have tranſcribed in another place, (ſee page 48.) From this, which is very ſimilar to the Obſervations made by the other gentlemen on that committee, the Society will perceive, that our Obſervations muſt have been made with conſiderable accuracy, as the reſult of the calculation is nearly the ſame.

Dr. WILLIAMSON's *Determination of the* PARALLAX *of the* SUN, *from his Obſervation of the* TRANSIT *of* VENUS, *at Philadelphia, June 3d,* 1769.

" WITH a Refracting Teleſcope, 24 feet long, which magnified near 100 times, I obſerved,

The ext. contact at $2^h. 11'. 31''$ } Mean Time.
Int. Do. at 2. 19. 10 }

" WITH a Micrometer of Dollond's conſtruction, fitted to a Gregorian Reflector, which magnified 100 times, I meaſured the diſt. of Venus from the limb of the Sun; alſo the diameters of the Sun and Venus, as follows:

Mean Time.				Neareſt Diſtance of the Centers of ☉ & ♀.		Neareſt Diſtance of the Limbs of ☉ & ♀.	
	h.	m.	ſec.	m.	ſec.	m.	ſec.
At	5.	43.	17	10.	14,12	5.	2,53
	6.	32.	18	11.	14,19	4.	1,46
	6.	33.	55	11.	13,23	4.	3,42
	7.	9.	26	12.	11,83	3.	5,82

I MEA-

" I MEASURED the diam. of Venus on the Sun, and found it to be $55'',42$. I alſo frequently meaſured the diam. of the Sun, on the day of obſervation, and the next day, and found it to be $31'.\ 31'',30$.

" FROM theſe data, I ſhall attempt to deduce the Sun's par. except that I ſhall make no uſe of the meaſure at $6^h.\ 32'.\ 18''$, which I ſuſpected was not accurate at the inſtant it was made, wherefore I immediately made another meaſure, viz. at $6^h.\ 33'\ 55''$.

" THE neareſt diſt. of the limb of the Sun from that of Venus at $5^h\ 43'.\ 17''$ And at $6\ \ 33\ \ 53$ } mean time compared together, give the apparent neareſt diſt. of their centers $10'.\ 3'',7$, or $603'',7$, and the parallax of Venus was at that time ſouth $6'',91$ nearly. Therefore, the geocent. neareſt diſt. of their centers was $610'',61$. Then,

" As 72626,3 the relative neareſt diſt.of Venus from the Sun,

" Is to 28894,9 her diſt. from the Earth.

" So is $610'',61$ the geocent. neareſt diſt. of the cent. of the Sun and Venus,

" To $242'',936 = 4'.\ 2'',936$, the heliocent. diſt. of their centers at the neareſt approach.

" As Sine $3^\circ.\ 23'.\ 20''$ the given inclin. of Venus's orbit to the ecliptic: Is to Radius,

" So is S, $242'',936$, the heliocent. diſt. of the cent. of the Sun from Venus, at the middle of the tranſit,

" To the Sine of $410'',5 = 1^\circ.\ 8'.\ 25''$, the Sun's diſt. from the node of Venus at the ecliptical conjunction.

" As S, of $1^\circ.\ 8'.\ 25''$, the Sun's diſt. from the node of Venus,

" Is to $10'.\ 10'',61$, the geocent. neareſt diſt. of their centers,

" So is Rad: to the S, of $8^\circ.\ 32'.\ 57'',6$, the angle of Venus's viſible path with the ecliptic.

" FROM $8^\circ.\ 32'.\ 57'',6$, the angle of Venus's viſible path,

" SUBT. 3. 23. 20, the inclination of Venus's orbit with the eclipt. and the remainder is $5^\circ.\ 9'.\ 37'',6$. Then

As

" As S, 5°. 9'. 37'',6 the diff. of the angle of Venus's visible path and the inclin. of her orbit, &c.
" Is to S, 8°. 32'. 57'',6 the angle of Venus's visible path with the eclipt.
" So is 2',392375 the given hor. motion of the Sun.
" To 3',95412 the hor. motion of Venus.

" As Rad. Is to T, 8°. 32'. 57'',6 the angle of Venus's visible path.
" So is S, 1°. 8'. 25'' the Sun's dist. from the node of Venus.
" To T, 10'. 17'',2 Venus's geocent. latitude.

" As 72626,3 the relative dist. of Venus from the Sun,
" Is to 28894,9 her distance from the Earth.
" So is 617'',2 her geocent. latitude.
" To 245'',56 her heliocent. latitude.

" From 15'. 45'',65 the semid. of the Sun,
" Take 27'',71 the semid. of Venus, and the difference is 15'. 17'',94., the dist. of the center of the Sun from the center of Venus at the inter. contact. But the geocent. nearest dist. of their centers was found 610'',61. From these (p. Euc. 1. 47) the length of half the transit line between the int. contacts is found to be 685',397 which divided by the hor. motion of Venus gives the semiduration of the transit between the two internal contacts 2^h. 53'. 20'',2.

" In the same manner, from the geocent. lat. of Venus, and the nearest dist. of her center from the center of the Sun, we find the time of Venus passing from the eclipt. conjunction to the middle of the transit 22'. 44'',9. Then from 5^h. 28' 47'', which I find to be the central time of the middle of the transit, deduct 22'. 44'',9, and the remainder, viz. 5^h. 6'. 2'',1, will be the apparant time of the ecliptical conjunction when the Sun's place was 2^s. 13°. 27'. 20'',5, as calculated by the Astronomer Royal, on the supposition that our Observatory is west of Greenwich 5^h. 0'. 35''.——To the Sun's place in the eclipt. add his dist. from the node of Venus 1°. 8'. 25''. The sum is 2^s. 14°. 35'. 45'',5, the place of Venus's ascending node.

From

" From the micrometer meaſures above given. it appears that the center of Venus was at her neareſt approach to the center of the Sun at 5h. 21′. 44″ mean time, or 5h. 23′, 59″ appar. time. But on account of the parallax of Venus, the appar. time at the center of the Earth was 4′. 48″ later, which brings it to 5h. 28′. 47″ as I have mentioned. From this deduct the ſemidurat. 2h. 53′. 20, and the remainder 2h. 35′. 27″ is the time of the internal contact at the center of the Earth. This contact I obſerved as above, at 2h. 29′. 10″ mean time, or 2h. 31′ : 25″ apparent time. This difference, therefore, viz. 4′. 2″, is the obſerved effects of Venus's parallax both in latitude and longitude.

" But on the ſuppoſition that the Sun's horizontal parallax, at her mean diſt. from the Earth was 8″,65, as Mr. Short has ſtated it at the former Tranſit, then his horizontal parallax, on the 3d of June, the day of the Tranſit, would have been 8″,5204, in which caſe the total effect of her parallax, to haſten the internal contact at Philadelphia, ſhould be 4′. 1″. Therefore,

" As 4′. 1″ is to 4′. ″2, ſo is 8″,5204 to 8″,556, the Sun's horizontal parallax on the day of the Tranſit, according to the foregoing Obſervations.

" Hence we have 8″,685, the Sun's horizontal parallax at his mean diſtance from the Earth. Then ſay,

" As the T, of the Sun's horizontal parallax : is to the ſemidiameter of the Earth,

" So is Rad. to the diſtance of the Earth from the Sun, viz. 94791100 Engliſh miles, taking the Earth's mean ſemidiameter at 3985.4 miles.

M

		H.	min.	ſec.
N. B. *Page* 78.	For Int. Contact	..	19.	10
	Read	2.	29.	10

An Account of the Transit of MERCURY *over the* SUN, *on* November *9th*, 1769. *N. S.*

IN the judgment of most Astronomers, the transits of Mercury and Venus over the Sun afford the best opportunities, for settling the longitudes of places on the earth, even preferable to that derived from the eclipses of Jupiter's satellites, when the parallax of the Sun is previously known. Those of Mercury happen frequently, and although they are of but little importance in determining the parallax of the Sun and the dimensions of the solar system, by reason of his great distance from the earth, and the difference of their parallaxes being less than that of the Sun; yet they have been carefully observed, for the purpose of settling his theory, and the longitudes of the places of observation. The Society therefore, sensible of the importance of this phœnomenon, both to the perfection of astronomy in general, and particularly for compleating the purposes designed to be answered by the observation of the transit of Venus, have appointed the same committee, with the addition of two other gentlemen, to observe the transit of Mercury on the 9th of November, 1769, in *Philadelphia*, that had been before appointed to observe that of Venus.

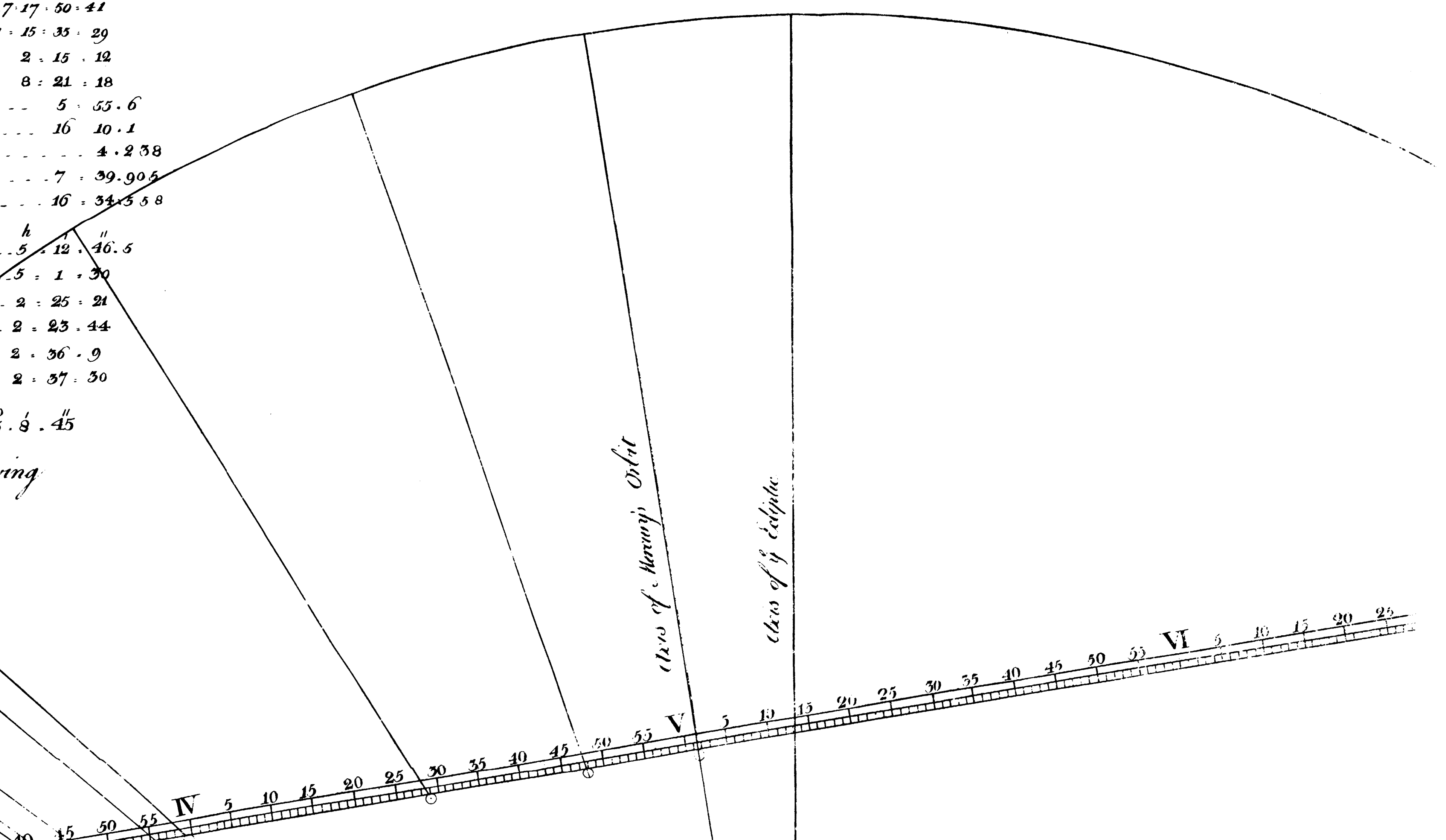
HAVING still the same instruments in our Observatory, which we used on the former occasion, together with a new Time-Piece made by Mr. *Duffield* of this city, with an ingenious contrivance of his, in the construction of the pendulum, to remedy the irregularities arising from heat and cold; we paid the utmost attention to the going of the clock, both before and after the transit. From comparing a sufficient number of corresponding altitudes of the Sun's limbs, we found that our clock was too slow for mean time 1′. 20″ and the equation of time being 15′. 49″,6 or to avoid fractions 15′. 50″; 17′. 10″ were added to the times of all our observations, as they were wrote down in the Observatory, to reduce them to apparent time. In this manner we obtained the time of the subsequent observations. Dr. *Williamson*, Mr. *Shippen* and myself used the same Telescopes, we had used before in observing the transit of Venus; excepting that on this occasion I chose that

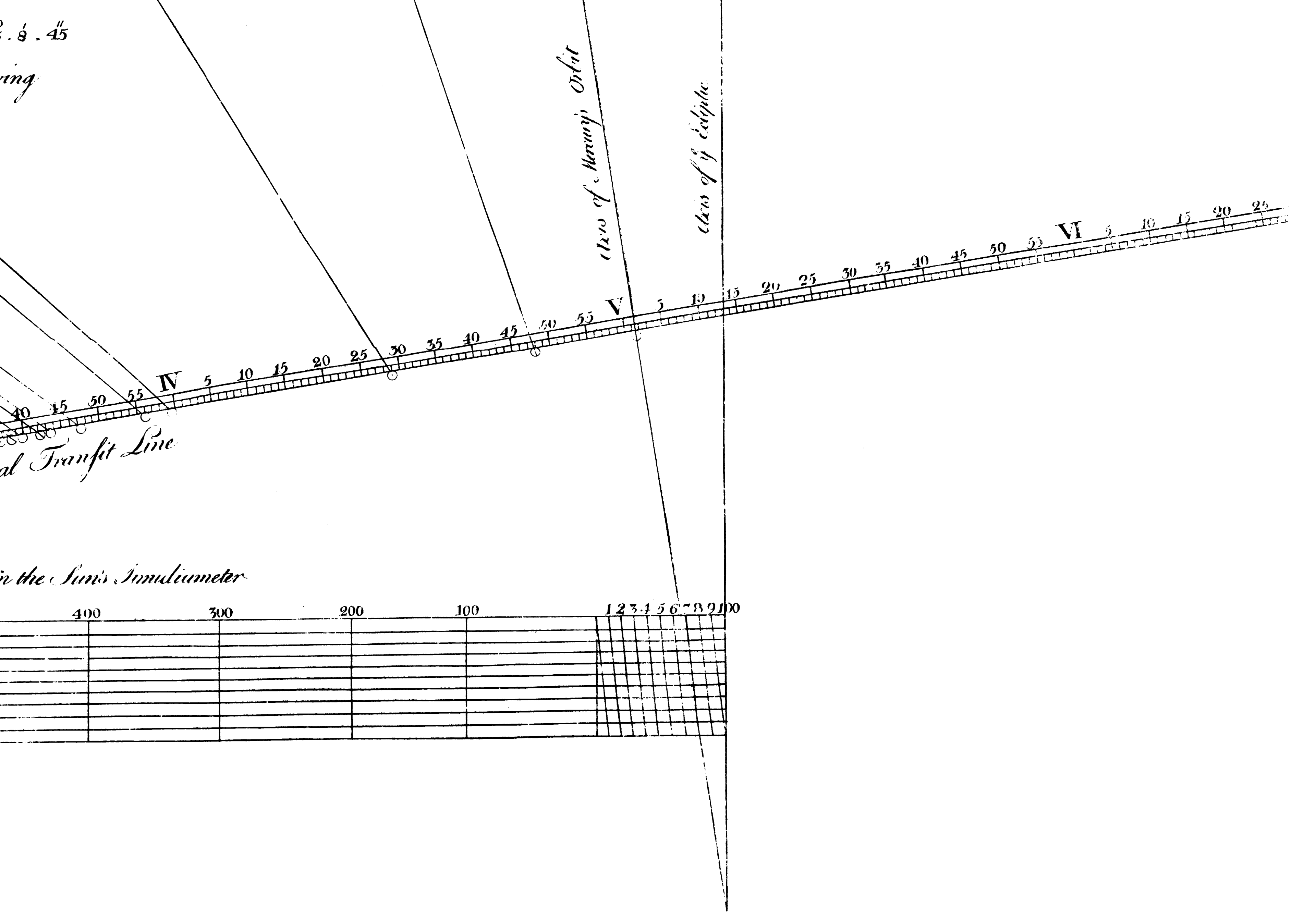
...nsit of Mercury, over the Sun, observed at Philad^a. Nov^r. 9 1769. N.S.

...7	17°	50′	41″
...	15	35	29
	2	15	12
	8	21	18
		5	55.6
		16	10.1
			4.238
		7	39.905
		16	34.358
h			
...5	12′	46″.5	
...5	1	30	
...	2	25	21
...	2	23	44
	2	36	9
	2	37	30

...8′.45″

...ring



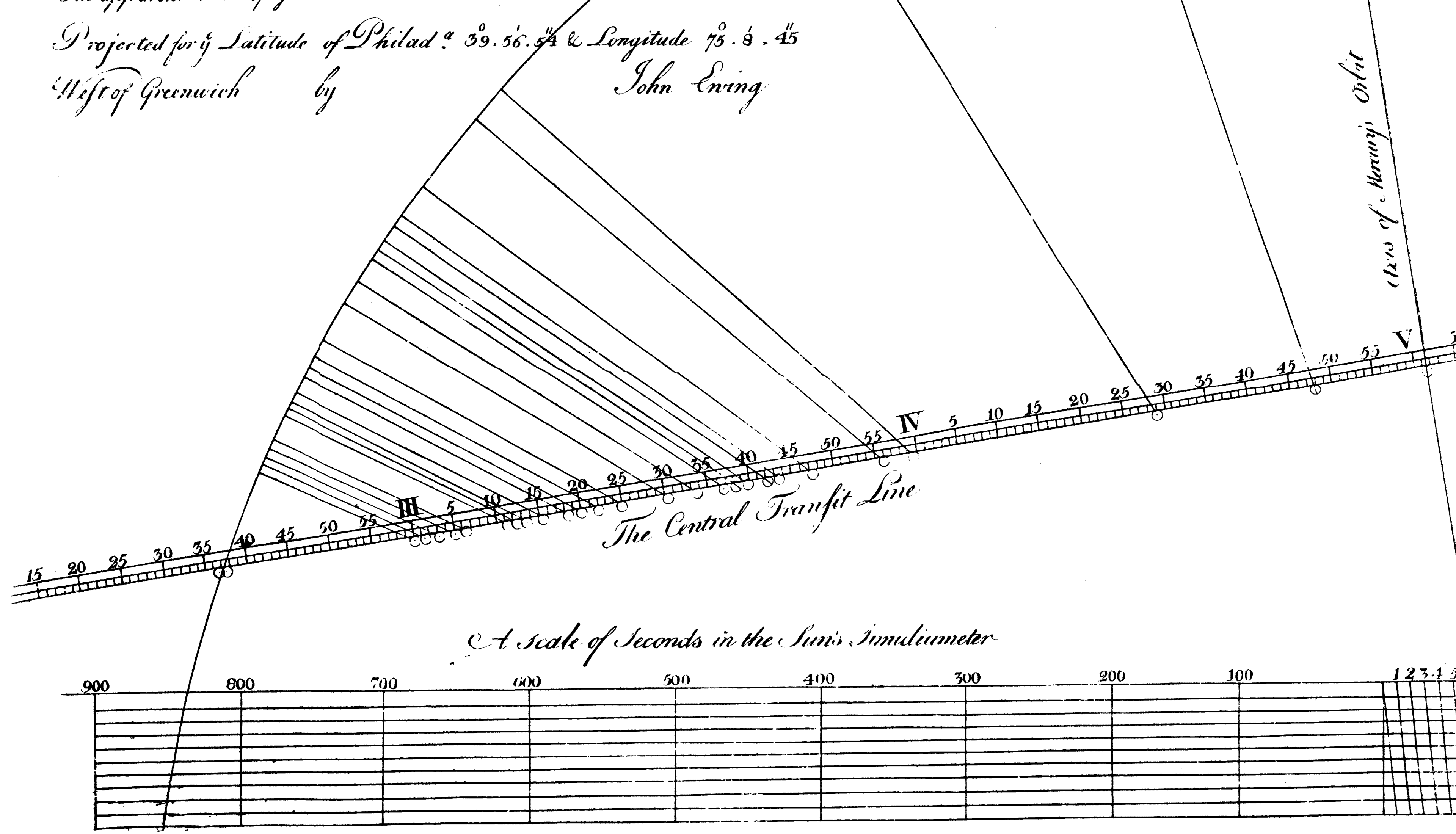

. 8 . 45
ring
Axis of Mercury's Orbit
Axis of y Ecliptic
IV
V
VI
al Transit Line
in the Sun's Semidiameter
400
300
200
100
1 2 3 4 5 6 7 8 9 100

A Projection of the Transit of Mercury, over the Sun, observed at Phila

The place of the Sun & Mercury at ye Ecliptical Conjunction	7 : 17 : 50 : 41
The place of the ascending Node of Mercury	1 : 15 : 35 : 29
The Suns Distance from ye Node of Mercury	2 : 15 : 12
The Angle of his visible path with ye Ecliptic	8 : 21 : 18
The Horary Motion of Mercury	5 : 55 . 6
The Semidiameter of ye Sun on ye Day of ye Transit	16 10 . 1
The Semidiameter of Mercury at ye same time	4 . 2 38
The Geocentric Latitude of Mercury at ye Ecliptical Conjunction	7 : 39 . 905
His Heliocentric Latitude at ye same time	16 : 34 . 3 5 8
The apparent time of ye Ecliptical Conjunction according to the Meridian of Philadelphia	h 5 : 12 : 46 . 5
The time of ye nearest Approach of ye Centers of ye Sun & Mercury	5 : 1 : 30
The central Semiduration of ye Transit between ye External Contacts	2 : 25 : 21
The central Semiduration of ye Transit between ye Internal Contacts	2 : 23 . 44
The apparent time of ye External Contact observed at Philada	2 : 36 . 9
The apparent time of ye Internal Contact observed at Phila	2 : 37 : 30

Projected for ye Latitude of Philada 39° . 56′ . 54″ & Longitude 75° . 8′ . 45″ West of Greenwich by John Ewing

Projected for ye Latitude of Philada. 39°. 56'. 54" & Longitude 75°. 8'. 45"
West of Greenwich by John Ewing



that power of the Telefcope which magnifies the diameters of objects an hundred times. Mr. *Evans* uied the Reflecting Telefcope formerly ufed by Mr. *Biddle* at the Capes.

On the day of the tranfit, we affembled together at the Obfervatory, adjufted our Telefcopes to diftinct vifion, appointed an affiftant to count the clock with an audible voice, and agreed that no other perfon fhould fpeak, nor move from his Telefcope, until both contacts were over; but write down his own obfervation feparately by himfelf, that it might be compared with the others. The fky being very ferene, and the limb of the Sun well defined in our Telefcopes, we obferved the contacts, as they are exhibited in the following table.

Obfervers.	External Cont.	Int. Cont	Par. in Vert.	Par. p. to his P.	Par. in his Path.
	h. m. fec.	h. m. fec.	''	''	''
Dr. Williamfon,	2 36. 5 Ap.T.	2. 37. 30	3,74	3,44	1,48 at the External
Mr. Shippen,	2. 36. 12	2. 37. 40			Contact.
Mr. Evans,	2. 36. 9	2. 37. 38	3,745	3,44	1,49 at the Internal
Myfelf.	2. 36. 9	2. 37. 30			Contact.

I happened to have that part of the limb of the Sun, on which Mercury entered, in the middle of the field of my Telefcope, with my eye intent upon it; fo that I am certain that there was not the leaft impreffion on the Sun's limb, perceptible by my Telefcope, a fingle fecond of time before I difcovered it. So that I am not furprized that Dr. *Halley*, who had obferved a tranfit of Mercury in the ifland of *St. Helena*, concluding that, that of Venus would be equally inftantaneous, expected, that the contact of her limb with the Sun might be determined to a fingle fecond of time. The atmofphere of Venus renders it quite otherwife, and produces an uncertainty of 5 or 6 feconds of time in judging of the contacts; whereas no fuch thing was perceptible in Mercury. The firft appearance of Mercury, on the Sun's limb, was a fteady fmall fpeck, black, well-defined, and not larger (in my Telefcope) than the dot of a pen. But that of Venus was tremulous, obfcure, and ill-defined, growing gradually darker as fhe advanced on the Sun. If Mercury has an atmofphere, it muft be fo rare and low, that his diftance from us renders it abfolutely imperceptible

ceptible with the Telefcopes that we ufed. At the internal contact, the crefcent of light round the body of Mercury clofed inftantaneoufly, fo that it might be judged of with more precifion than that of Venus; his atmofphere giving us no difturbance in this cafe. We could not have a fairer opportunity, for afcertaining the truth of thefe conclufions; as our Telefcopes were in good order, and well adjufted, and the fky was remarkably clear and ferene on both of thefe days. On the firft of them, not a cloud appeared from morning till evening, and on the latter, none till about four o'clock, when the Sun was very low; and both the tranfits began between two and three o'clock, in the afternoon.

About three o'clock, I applied myfelf to the Micrometer to meafure the diameters of the Sun and Mercury, and the neareft diftance of their limbs, while Dr. *Williamfon* read off the divifions of the Micrometer, and a third perfon wrote them down, with the times of making them. Thefe meafures make the diameter of the Sun on the 9th of *November* 1769, 32′. 20″,2 or his femidiameter 970″,1 feconds, and the femidiameter of Mercury 4″,238. The meafures of the leaft diftances of their limbs reduced to minutes and feconds of a degree, with the parallaxes of Mercury adapted to the apparent times of the obfervations, as they are determined from a very large projection of two inches to a fecond of his hor. parallax, are fet down in the following table.

Apparent Time. h. m. fec.	Neareft Dift. of Limbs of ☉ & ☿ ′ ″	Par. of ☿ in the Ver. ″	Par. per. to his Path, ″	Par. in his Path, ″
2. 59. 40	1. 54,1	3,81	3,4	1,7 5
3. 1. 0	2. 0,62	3,81	3,396	1,73
3. 2. 35	2. 8,284	3,82	3,393	1,745
3. 4. 30	2. 20,832	3,825	3,39	1,765
3. 6. 10	2. 26,048	3,826	3,386	1,78
3. 10. 33	2. 48,216	3,835	3,38	1,83
3. 12. 6	2. 57,244	3,841	3,379	1,84
3. 12. 56	3. 2,56	3,844	3,376	1,85
3. 15. 4	3. 13,744	3,850	3,375	1,865

Apparent

Apparent Time.	Nearest Dist. of Limbs of ☉ & ☿	Par. of ☿ in the Ver.	Par. per. to his Path.	Par. in his Path.
h. m. sec.	′ ″	″	″	″
3. 18. 4	3. 26,032	3,856	3,369	1,87
3. 19. 18	3. 30,596	3,86	3,366	1,888
3. 21. 30	3. 41,68	3,864	3,363	1,915
3. 24. 0	3. 51,684	3,875	3,36	1,95
3. 30. 0	4. 20,8	3,895	3,34	2,0
3. 33. 30	4. 35,144	3,90	3,338	2,02
3. 36. 40	4. 51,444	3,905	3,334	2,04
3. 37. 40				
3. 39. 25	5. 2,202	3,915	3,33	2,065
3. 41. 10				
3. 42. 50	5. 21,406	3,930	3,325	2,09
3. 46. 58	5. 37,184	3,935	3,32	2,145
3. 55. 32	6. 8,48	3,96	3,30	2,2
3. 59. 10	6. 26,084	3,97	3,29	2,24
4. 28. 50	7. 54,756	4,0	3,22	2,42
4. 47. 50	8. 35,18	4,02	3,15	2,51

N. B. In the above Table, the measure at $2^h. 37'. 40''$ was taken between the nearest limb of the Sun and the interior limb of Mercury nearest to the Sun's center, and is $5'. 2'',202$, the same with the distance of their nearest limbs at $3^h. 39'. 25''$: So also the distance between the nearest limb of the Sun, and the interior limb of Mercury, at $3^h. 41'. 10''$, was the same with the distance of their nearest limbs at $3^h. 42'. 50''$, viz. $5'. 21'',406$. The same is to be said of the last measure, which was taken from the nearest limb of the Sun to the limb of Mercury nearest to the Sun's center.

If a computation be made from the above measures, the apparent nearest distance of their centers will be found to be $451'',914$. But Mercury was then depressed by parallax $3'',11$; so that the geocentric nearest approach of their centers was $455'',024$, which happened at $5^h. 1'. 15''$ ap. time, when his par. in the vert. was $4'',042$, and in his path $2'',53$, and perpend. to his path $3'',11$.

THE horary motion of Mercury as ſeen from the Earth is alſo determined from the above meaſures to be 5'. 56'',941 = 5'',94856, which is nearly the ſame with what is given by Dr. Halley's tables of Mercury. On the day of the Tranſit, he moves, by them, at the rate of 15'',334 per hour. The Sun's horary motion on that day is ſtated in the Nautical Almanac at 2'',516, and their difference, viz. 12,818 is his hor. motion from the Sun, as ſeen at that diſtance. Then ſay,

As the diſt. of ☿ from ⊖, is to his diſt. from ☉, So is this hor. mot. to his hor. mot. from ☉, as ſeen from ⊖

4. 830,2920
4. 495,3305
1. 107,8203
5. 603,1508
0. 772,8588 = 5',92733 = 5'. 55'',6398 ☿'s hor. mot. from ☉, as ſeen from ⊖.

15. 334
2. 516
17. 850 = 1. 251,6382
12. 818 = 1. 107,8203
11. 214,2067 = the log. cot. of half the incl. of ☿'s orbit with the ecliptic = ½ 6°. 59'. 20''.
12. 322,0270
Log. Tang. 11. 070,3888 = 85°. 8'. 22''
86. 30. 20
171. 38 42
8. 21. 18 = the angle of ☿'s viſible path with the ecliptic.

As Rad : Sec, 8°. 21'. 18'' : : geo. neareſt diſt : the geo. lat. of ☿

10. 000,0000
10. 004,6342
2. 658,0343 = 455'',024 = geo. neareſt diſt.
2. 662,6685 = 459,905 = 7'. 39'',905 = geo. lat. of ☿

As diſt. of ☿ from ☉ : his diſt. from ⊖ : : geo. lat. : his heliocent. latitude

4. 495,3305
4. 830,2920
2. 662,6685
7. 492,9605
2. 997,6300 = 994'',558 = 16'. 34'',558 the hel. lat. of ☿

As

As T, 6°. 59′. 20″ : R : : T, 16′. 34″,558 : Sine of ⊙'s diſt. from the node of ☿

9. 088,4133
10. - - - -
7. 683,0140

8. 5$\mathrm{\,}$54,6007=2°. 15′. 12″,2 ⊙'s diſt. from the node of ☿

459,905
455,024

914,929=2. 961,3873
4,881=0. 688,5088

3. 649,8961
1. 824,94805=66″,8264= the length of part of the tranſit line between the middle of the tranſit & the ecl. conjunct.
2, 551,0104 ☿'s hor. motion in ſeconds.

—1. 273,9376=0^{h}. 187905=0^{h}. 11′. 16″,458 the time between the middle and ecliptical conjunction.

974,338 the ſum of the ſemidiameters of ⊙ and ☿
455,024 the geo. neareſt diſt. of their centers.

1429,362=3. 155,1422
519,314=2. 715,4300

5. 870,5722
2. 935,2861=861″,561 half the length of the tranſit line from the external contact.
2. 551,0104= the hor. mot. of ☿ on ⊙, as ſeen from ⊖

0. 384,2757=2^{h}. 422567=2^{h}. 422567=2^{h}. 25′. 21″,24 the ſemiduration from the external contact.

965,862 the dif. of the ſemidiameters of ⊙ and ☿
455,024 the geo neareſt diſt. of their centers.

1420,886 3 152,5691
510,738 3. 708 2833

5. 860,8524
2 930,4262= 851,974=the length of half the tranſit line from the internal contact.
2. 551,0104

0. 379,4158=2^{h}. 39561=2^{h}. 23′. 44″,196

Now to 2^{h}. 36′. 9″ the time of the exter. contact,
Add 2. 25 21 the ſemidur. between the external contacts.

The Sum,	5.	1.	30	is the time of the neareſt approach of their centers,
To this add,		11.	16,5	the time from the middle to the ecl conjunct.
The Sum,	5.	12.	46,5	is the ap. time of the ecl. conjunct. at Philad.
To this add,	5.	0.	35	the diff. of merid. between Greenw. & Philad.
The Sum,	10.	13.	21,6	is the time of the ecl. conjunction at Greenw.

when

when the Sun's place, according to the Nautical Almanac, is 7s. 17°. 50', 41'', and that of Mercury is, 1s. 17°. 50'. 41'', by Dr. Halley's tables. From this subtract 2°. 15'. 12'', the Sun's dist. from the node of Mercury, and the remainder 1s. 15°. 35'. 29, is the place of his node at that time.

The PROJECTION *of the* TRANSIT *of* MERCURY. *Pl.* V.

THE following projection of the Transit of Mercury over the Sun, on the 9th of November, 1769, was made from the foregoing measures and calculations, on the supposition that the Sun's horizontal parallax, at his mean distance is, 8'',65, and therefore, 8'',7437 on the day of the Transit. In this case, the horizontal parallax of Mercury, at his mean distance, will be 14'',1132, and on the day of the Transit 12'',7856, and therefore his horizontal parallax from the Sun, on that day is, 4'',0419, being the difference of their parallaxes.

THE delineation was made in the same manner as that of the Transit of Venus. The elements for it were collected from the preceeding calculation, and the parallaxes of Mercury were measured upon a very large projection, for that purpose, adapted to the apparent times of the Micrometer measures, and applied to the projection. By these, the apparent places of Mercury were determined, as seen at Philadelphia; and small circles were drawn round them, with the Radius 4'',238, to represent his disc, on the face of the Sun. From the limbs of the Sun and Mercury, lines were drawn, in the direction of their centers, of the precise length exhibited in the foregoing table of measures.

UPON the whole, I have given a full and faithful account of our Observations of the Transits of Venus and Mercury, in the foregoing sheets; and if they should be found, in the conclusion, to contribute any thing to the advancement of Astronomical Knowledge, it must reflect an honor on our new Observatory, and give pleasure to all the Lovers of Science, as well as to,

Gentlemen,
Your most obedient
And very humble Servant,

Philadelphia, July 19th, 1769. JOHN EWING.